"An appearance of strength"
The Fortifications of Louisbourg

Volume One

Bruce W. Fry

Parks Canada Parcs Canada

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Cover: Louisbourg under siege, 1745. (Bibliothèque Nationale, Paris.)

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Contents

Volume One

5 Preface
7 Acknowledgements
9 Introduction
11 Gunpowder: Its Impact on European Warfare
15 Medieval Fortifications
19 Gun Towers: Precursors of Angle Bastions
23 Early Bastioned Systems: Italy and the Netherlands
29 The First French Military Engineers
37 Perfection of the Art: Vauban
47 Louisbourg: A Historical Introduction
53 Louisbourg: The Setting
  53 Choice of Site
  56 Physical Environment
  57 Post-Demolition History to 1960
61 The King's Bastion
  61 Restoration Programme and Initial Research
  62 Architectural Components
  63 Construction Concepts
  64 Escarps
  68 Ramparts and Casemates
  76 Parapets, Embrasures and *Guérite*
  84 The Gorge of the Bastion: Barracks and *Place d'Armes*
87 The Dauphin Half-Bastion
  87 Description and History
  90 Archaeology: The Research Strategy
  92 Ramparts: Escarps
  93 Ramparts: Terreplein and Interior Slope
  95 Ramparts: Circular Battery
  98 Parapets
  102 Cavalier
  103 Barracks and Powder Magazine
  106 Officer's Guardhouse
  106 Tenaille Front: Guardhouses
  108 Tenaille Front: Latrine
  108 Tenaille Front: Gate
111 Curtain Walls
  111 King's-Dauphin Curtain
  114 Queen's-King's Curtain
119 Completion of the Landward *Enceinte*
  119 The Queen's Bastion
  120 Queen's-Princess Curtain and Queen's Gate
  121 The Princess Bastion
125 The Landward Defences: Outworks
135 Enclosing the Town
  135 *La Nouvelle Enceinte*
  137 The Quay
141 Harbour Defences
  141 The Royal Battery
  144 The Island Battery
  145 The Rochefort Point Battery
147 The Sieges
  147 The 1745 Siege
  148 The 1758 Siege
  150 Fieldworks
153 Conclusions
163 Appendix A. Louisbourg: Construction Chronology.
165 Appendix B. The Franquet *Mémoires*.
167 Appendix C. Calculations to Determine the Original Elevation of the Terreplein of the King's Bastion Ramparts.
173 Appendix D. The Relationship between the Slope of the Glacis and the Superior Slope of the King's Bastion Parapets.
175 Appendix E. Calculations to Determine the Dimensions of the King's Bastion Embrasures.
179 List of Abbreviations
181 Endnotes
199 Glossary
207 Selected Bibliography

Nothing now remains to be done to the defences except to complete the little covered way of the barracks on the side facing the town so as to safeguard the entrance to the barracks and the gorge of the King's Bastion should the need arise, and to give an appearance of strength to this bastion....

Etienne Verrier

Preface

The study of Louisbourg's fortifications and their European antecedents presented in the following pages owes its origins to the author's involvement in the Fortress of Louisbourg restoration project initiated by the Canadian government in 1961. Joining the staff as an archaeologist in 1963, the author excavated various elements of the fortifications which were destined eventually for reconstruction in their original form. In 1966 the author assumed responsibility for directing the entire archaeological programme and participated in the design work which translated the research findings into physical reality.

At that time, the opportunity to synthesize and to present all the pertinent evidence recovered was limited by the economical and political pressures to provide tangible results for the millions of dollars being spent on the reconstruction. There was, moreover, a vital element missing: Louisbourg was not a unique creation, but the logical outcome of a tradition of fortress-building extending back to the Middle Ages and beyond. To explain Louisbourg, that tradition had to be understood also.

Thus the author embarked upon a research programme to investigate the origins of the fortification concepts applied at Louisbourg, and spent the better part of two years examining 16th- to 18th-century archival material in France and inspecting surviving fortifications from that period. The odyssey led mainly to the frontiers, old and new, of France, but also to England, the Low Countries, and Malta, where some of the finest examples of bastioned defences covering the entire period are to be found. Nor did the route lead directly back to Louisbourg. In 1973 the author was recalled to assist in the expanding archaeological programme of Parks Canada within its Quebec Region, which included excavations on the 17th-19th century fortifications of Quebec City.

As the reconstruction phase of the Louisbourg project neared completion, it became time to attempt – at least retrospectively – to return the research horse to its proper place before the developmental cart and to offer in one report a comprehensive interpretation of the fortifications and their significance. This the author agreed to undertake by returning to Louisbourg in the winter of 1978/79.

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This undertaking would have been impossible without the assistance and collaboration, directly or indirectly, of many colleagues over two decades. To do full justice to these contributions would require no less than a complete roll-call of all who have worked in one capacity or another in the research units of the Louisbourg project since its inception in 1961. Some individuals nevertheless should be singled out. Edward Larrabee, then Senior Archaeologist at Louisbourg, patiently introduced me to North American archaeology and historical archaeology in particular. F.J. Thorpe, now Senior Historian at the National Museum in Ottawa, and B.C. Bickerton, now Professor of History at Carleton University, Ottawa, were responsible for the vast programme of data collection and — more important — the ordering of those data so that they could be accessible to future researchers: the foundation of Louisbourg's research programme. Historians whose research notes, memoranda and internal reports were of particular value to the present study are Wendy Cameron, Margaret Fortier, Jean Hankey and Linda Hoad.

Completion of the Dauphin Bastion excavations, much less the subsequent report and design, could not have been achieved without the perseverence and efforts of Charles Lindsay, who has acted more recently as a patient sounding-board for the ideas and interpretations contained in the present report. Throughout the author's involvement with Louisbourg, he has been aided — and often guided — by T. Marmon Smith, who prepared the line drawings accompanying this report. Art Fennell has worked long hours with negatives, often of less than desirable quality, to produce the halftone illustrations.

In Europe the author was set on the right track by General Nicolas, ex-director of the Ecole du Génie at Versailles; by Jean Boudriot, a military historian with an unparalleled knowledge of 18th-century military life, and by Jean Palardy, who opened many doors to archives and military establishments. Mlle. Lacrocq of the Bibliothèque and Archives du Génie was of the greatest assistance in the course of studying the maps, plans and memoranda of the Corps du Génie, many of which are reproduced as illustrations in Volume Two of this work.

A profound note of gratitude is due Parks Canada (now part of Environment Canada, formerly part of the Department of Indian and Northern Affairs), for the extent of its commitment to Louisbourg and for supporting the extended periods of research, in Canada and overseas, that were essential to this study. Special thanks are due to John Rick, then Head of National Historic Parks and Sites Research Division in Ottawa, and to John Fortier, now Park Superintendent of Louisbourg.

Introduction

In 1717 the French government determined to build a fortified harbour town on the Atlantic coast of Nova Scotia. Nineteenth-century romantic hyperbole gave the town the reputation of a mighty fortress because of the supposed strength of its fortifications and the use made of its sheltered harbour by privateers that had preyed on British colonial shipping. This paper is, first and foremost, a study of those fortifications, an examination by archaeological methods of what was built, why, and the extent to which the intended functions were fulfilled.

No site can be studied devoid of its context. To understand the what and the why, a discussion of the evolution of the fortification principles applied to Louisbourg's walls — the bastioned system of defence — is essential.

The origins of that system will be discussed in relation to the patterns of warfare and the weapons in use at the time the modern political configurations of Europe began to emerge. Of recent years, renewed interest in military history and the appearance of several publications have rendered the technicalities of 17th- and 18th-century military architecture and siegecraft less of an arcane speciality reserved to an initiated few, obviating the necessity of delving into such detail as would have made this paper disproportionately long. The background herein presented will establish the desiderata of 18th-century fortifications by examining the treatises of that period and relating them to what was actually built in Europe. Examples are based on either the maps and plans prepared by the 17th- and 18th-century cartographers and engineers, or on-site inspection of surviving fortifications. The Louisbourg fortifications will then be compared to the typical, evaluating the archaeological evidence against the specific documentary evidence of Louisbourg's engineers and administrators.

The reports, recommendations and criticisms of those involved in the building of Louisbourg diminish the distance between us and the original inhabitants; a strikingly modern tone rings through much of the official correspondence, adding to the sense of historical continuity when the 20th-century records pertaining to the rebuilding of Louisbourg are examined. (The author's translations attempt to retain the sense of the original; key passages or ones where the interpretation is open to question are cited verbatim in the endnotes.)

This does not pretend to be a historical study, nor is it the account of the reconstruction programme which, now nearing completion, has seen the rebirth of a major portion of the town and its fortifications although reference to the programme is made wherever pertinent. Rather it is an attempt to explain the unusual phenomenon of an Old World fortress in a New World context by means of a synthesis of archaeological, historical and architectural evidence.

Despite the archaeological orientation of the report, virtually no reference to artifacts is made and the reader who expects to find numerous examples of French ceramics or even building hardware illustrated in these pages will be disappointed. Such material was recovered from the excavations in copious quantities; however, they could contribute little to an understanding of the fortifications and are best left to separate studies. For the present paper, the stones themselves, the ruined walls and mounds of rubble are the artifacts that yield the sought-after information.

The illustrations accompanying the report are presented in a separate volume for the convenience of the reader who may wish to consult them alongside the text. To keep the size of the report within reasonable bounds, the author has selected only those illustrations which directly aid the interpretations presented in the text. Photographs and drawings simply demonstrating that certain features were indeed observed during the course of the excavation but not otherwise contributing to an understanding of the discussion have been left out on the grounds that, interesting though they may be to the excavator, one section of collapsed masonry or one excavation in progress looks very much like another, and that ground-level views rarely allow the reader to envisage the whole work. Low-level aerial photography would have been the ideal medium to record the existing fortifications in Europe, but this was unfortunately not possible.

The maps and plans of Louisbourg in particular tell much of the story, almost without recourse to the text. For this reason, they are presented in sequence relative to one another which sometimes does not coincide entirely with the sequence in the text. Tempting though it is to regard the numerous closely dated plans as a faithful record of construction progress, almost like a series of aerial views taken each year, there are limitations. In the first place, the plans were often copied several times for distribution to various authorities, a process which is liable to cause errors and omissions; secondly, the distinction between what had been already built and what was proposed is not always apparent; thirdly, a plan may have been intended to illustrate one particular feature in detail, and other features shown are not necessarily drawn accurately but may serve simply as background. Finally, we should not overlook the natural tendency to present matters as tidily and in as completed a manner as possible. The bulk of the plans were, after all, accompaniments to progress reports and it was in the interests of the engineers to put the best interpretation possible on their accomplishments. The various siege plans also present problems; it is not easy to locate and draw enemy siege positions accurately whilst under constant artillery bombardment.

In any study dealing with fortifications, the number of technical terms no longer in common usage necessitates the inclusion of a glossary. Usually a glossary will give a simple, short definition of a term, but this overlooks the fact that some terms changed meaning over the course of centuries, or meant different things to different writers. To avoid confusion, in this glossary any alternatives are given and sources cited; where sources are generally in agreement, only one source is given unless the term is sufficiently common not to warrant such specific reference.

Throughout the course of the research, in particular as far as the Louisbourg material was concerned, two basic linear measuring systems were involved: the documentary sources used the *pouce*, *pied* and *toise* units of the Ancien Régime; the contour surveys, excavation grid and archaeological measurements were all derived from the standard units of feet and tenths of feet. To this was added another dimension with the decision of the Canadian government to go metric. Thus, wherever possible, all measurements derived from field recording in Imperial units have been converted to metric; where inclusion of the original figures would help clarify the arguments presented, or in the case of direct citations from earlier manuscripts, the Imperial units have been retained. The contour plans of the fortress area (Figs. 68, 255) have been reproduced as originally drawn, since the survey was based on 5-ft. intervals which did not lend themselves readily to conversion.

While the old French *pouces*, *pieds* and *toises* translate conveniently into inches, feet and fathoms, the correlation is not exact. The French units are slightly larger, which can cause a considerable variation. Unfortunately, this was overlooked in many of the 17th- to 19th-century treatises in English purporting to explain the exact method of Vauban; a *toise* is usually represented as 6 English feet. In fact, the variation is:

1 *pouce* = 1-1/16 in. (1.0656 in.)
1 *pied* = 1 ft. 0-3/4 in. (1.066 ft.)
1 *toise* = 6 ft., 4-3/4 in. (6.396 ft.)

A conversion table sufficiently accurate for the purposes of the present report permits measurements to be expressed in English, old French and metric units:

Pieds x 1.066 = Feet
Feet x 0.938 = *Pieds*
Metres x 3.076 = *Pieds*
Pieds x 0.325 = Metres
Metres x 3.280 = Feet
Feet x 0.3048 = Metres

The invasion of the Italian Peninsula in 1494 by Charles VIII of France has frequently been regarded as the stimulus that led to a radically new form of fortification. Macchiavelli's comments on the inability of Neapolitan fortresses to resist French artillery are cited by Louis-Napoléon Bonaparte[1] and more recent writers have also regarded the invasion as a turning point,[2] yet it would be surprising to see a prompt and effective reaction to a military threat in a sphere of human activity that is traditionally slow to respond to change. Moreover, ad hoc solutions had been applied throughout Europe since firearms were developed in the 14th century. Convenient as it may be to use the beginning of the Italian Wars as a milestone, Charles's campaign was not revolutionary in either offensive or defensive warfare.

To examine first of all the technology and tactics available to the aggressor, the quality of French artillery was undoubtedly superior to that of contemporary armies elsewhere, but the difference was of degree rather than kind. The Italian states were well versed in the art of gunmaking and in the employment of siege artillery from the 14th century onwards.[3] Innovation and experiment were encouraged by these small, independent, rival states, but their size was obviously a limiting factor on the armies and weapons they could afford.

In France, on the other hand, the gradual coalescence of a nation-state slowly but surely guaranteed the concentration of power under the monarchy. More specifically, Charles VIII benefitted from the legacy of his provident if unloveable father, Louis XI, who left him, according to Bonaparte, three treasures: well-fortified towns across the kingdom and on the frontiers; a large army (4500 men at arms, 60 000 professional and mercenary soldiers), and an equally large and powerful artillery.[4]

The origins of gunpowder and its first practical application as a propellant are obscure. It is clear that from early in the 14th century, primitive pieces played an ever-increasing role in warfare; descriptions of the early forms and their impact on warfare are given by several authors.[5] The important point is that technology and logistics combined to limit the use of the evolving artillery to situations where high mobility was not essential, namely the attack and defence of places. The earliest documentary reference to cannon in fact indicates their use as defensive weapons,[6] while the earliest manifestiations in military architecture reflect a desire to modify defences to permit cannon to be fired on attackers, rather than a need to restructure defences the better to resist siege artillery. In works that were otherwise characteristically medieval in appearance, arrow slits, so long the basic element of defensive fire-power, began in the latter half of the century to give way to gun-ports.[7]

Improvements in artillery were soon to demonstrate the inadequacy of this response. The protracted struggle of the Hundred Years War (1337-1453) between England and France provided both the incentive to development of and practical proving-grounds for the new weapons. Towards the end of the war, both sides placed increasing importance on artillery trains for taking and holding strategic places, but French superiority achieved by the Bureau brothers was a major contribution to the expulsion of the English from Normandy and Guienne, 1450-51. Bonaparte recounts that it took little more than a year for the French to recapture 60 strongholds thanks to the improved artillery.[8] He further notes that the Bureaus introduced cast-iron cannonballs, the use of which permitted a reduction in calibre while at the same time causing much more damage against masonry. The use of iron balls was not unknown, as the Moors had used them in Spain in the 14th century[9] and their manufacture is recorded in Italy as early as 1326,[10] however, prior to the mid-15th century, stone missiles were preferred as being easier to make and therefore cheaper. It would appear that the Bureaus improved casting techniques, thereby reducing production costs.

The French monarchy was not slow to benefit from the advantages that these developments brought: Charles VII was able to secure his throne against English claims and put an end once and for all to English control of French territory, and Louis XI could continue the consolidation of the kingdom by finally breaking the power of his feudal vassals, foremost of whom were the dukes of Brittany and Burgundy. It was therefore unfortunate that Charles VIII, once secure and powerful at home,[11] felt irresistibly drawn by dreams of conquest of Italy.

The artillery train he took with him showed some improvements over that developed by the Bureau brothers, and afforded a corresponding improvement in mobility and flexibility. The bronze guns were cast with trunnions,[12] permitting greater ease and manoeuvrability in achieving a desired trajectory. Equally important was the employment of wheeled gun-carriages, allowing more efficient progress on the march and more rapid installation in siege positions. And the use of cast-iron cannonballs, which had reduced cannon calibre and therefore size and weight, further contributed to the mobility of the French force that descended upon Naples with approximately 100 "medium calibre" guns.[13]

The question of calibre is in itself significant. Throughout the evolutionary period of the new weapons, little thought had been given to standardization. Now, during the reign of Charles VIII, attempts to reduce the variety of cannon and calibres were made. The Hapsburg emperor Charles V then concerned himself with regulating the manufacture and testing of cannon and was emulated by his rival Francis I in France. Under Henry II (1547-59) the number of different calibres used by the French artillery was reduced to six, ranging from the full cannon of 6-*pouce* 6-*ligne* calibre (ca. 16.6 cm) weighing 5400 *livres* and firing shot weighing 33 *livres* down to the falconet of 1-*pouce* 10-*ligne* calibre (ca. 5 cm) weighing 450 *livres* and firing a one-*livre* ball.[14] At this stage, artillery had reached the degree of sophistication that was to obtain, with minor modifications, for the next 200 years. The dominant form was, in essence, a smooth-bore tube case in iron or, more frequently, bronze. Manufacturing techniques not being equal to the complexity of the task, the early form of breech-loaders were abandoned and muzzle-loading pieces were the norm.

Before examining the effects of these developments on the art of defence, a brief review of the weapons and tactics employed in warfare, and in sieges particularly, throughout the same period is pertinent for their bearing on the evolution of fortifications.

If artillery had progressed to a level of standardization and satisfactory performance sufficient to ensure a long period devoid of radical innovation and experimentation by the middle of the 16th century, this was far from true in the case of small firearms. There is, indeed, no distinction made in the early documentation between a cannon and a hand-gun, the latter being "merely a cannon in miniature."[15] While the guns were occasionally used in the field, as appears to have been the case at the battle of Crécy (1346), loading was slow and awkward. The actual firing was equally laborious and hazardous and, not unnaturally, large, stationary targets offered more chance of success. Thus, shortly after the initial appearance of the new weapons, attention was concentrated on achieving size rather than mobility: guns were seen as supplementing the great siege engines of the Middle Ages rather than as the individual weapons of the foot-soldiers. Here at last was a means of hurling large missiles with greater force and accuracy than the catapults, mangonels and trébuchets which had originated in Roman times. (The trébuchet appears to have been in use up until the end of the 15th century, as one was used with great effect by the defenders of Rhodes against the besieging Turks in 1480.[16]) Both the technology and nature of warfare during the Hundred Years War favoured the tendency to what Hogg has styled "giantism in ordnance."[17]

In contrast, gunpowder appeared to offer little advantage over the conventional weapons used by fighting forces, either on horse or on foot. The English, in particular, saw no reason to seek an alternative to the longbow, adopted as a national weapon before the Hundred Years War and used with such deadly effect throughout that series of conflicts. The accuracy, rate of fire, range and awesome penetrating power[18] of the cloth-yard shafts remained unchallenged until the end of the 15th century, and proved decisive at Crécy (1346), Poitiers (1356) and Agincourt (1415). Deceptively simple in appearance and operation, the longbow nevertheless required considerable strength and lengthy training for an archer to be proficient. For this reason, Continental armies favoured the crossbow. Slower and more cumbersome, it had the advantages of being mechanically drawn and discharged, and hence was easier to operate.

In the field, archers and crossbowmen could not function independently of other units: battle was usually joined by more heavily armed shock troops, either infantry or cavalry. Medieval traditions of chivalry died hard and the French especially were reluctant to abandon the idea of a decisive victory won by a spectacular charge of heavily armoured knights in full panoply. Initial response to the improved effectiveness of long-range weapons was not to abandon this tactic but to develop armour ever heavier and more awkward, even encasing the horses themselves. But to be effective, cavalry had to operate under certain conditions: a charge across broken, boggy ground could only end in disaster, and a direct charge against a dismounted enemy in a well-defined position was equally costly and futile. During the same period, moreover, there developed a weapon that was to have a profound influence on the nature of warfare: the pike. Its potential was first realized at Courtrai in 1302, when French knights, charging across a bog, were humiliatingly repulsed by Flemish commoners armed with pikes behind an entrenched position.[19] The superiority of the nobility and the invincibility of armoured cavalry alike suffered a rude shock.

The lesson was not overlooked by the Swiss, who successfully fought for their independence from Hapsburg rule at this time. In 1315 at Morgarten, Hapsburg cavalry, unable to manoeuvre in a narrow defile, was routed by a concerted rush of pikemen, and thereafter the pike, more so than the legendary crossbow of William Tell, became the Swiss national weapon. Like the longbow, it was a simple arm, and success depended on the stamina and discipline of well-trained troops. Subsequent victories in the protracted struggle for autonomy served to reinforce their reliance on the pike, but it was in the 15th century, notably in their victories over the Burgundian forces, that the reputation of the Swiss was really established and led to their employment as mercenaries throughout Europe. A defensive square of pikemen presented an impenetrable barrier to cavalry; a rapid advance shattered the ranks of opposing forces. The Swiss tactics were, however, developed under special conditions in response to a specific threat and proved successful only when battle could be joined in similar conditions. A threatened herd of musk-ox forms a circle, heads lowered and massive horns out-thrust, so that no predator can break through, but this defence is suicidal against hunters with rifles. So too with the Swiss pikemen: invincible against cavalry or infantry in close combat, they were defenceless against long-range attack. The pike was evolving as the English longbow was winning its most celebrated victories and the Swiss were not employed by the French after the Hundred Years War so the two weapons were never pitted against each other in the field. But as the English armies faded from the scene, developments in firearms and tactics led to the decline of Swiss military dominance early in the 16th century.

Throughout the 14th and early 15th centuries, the influence of firearms was primarily reflected in siege warfare and the development of guns capable of outperforming mechanical siege artillery. In part due to a preoccupation with capturing places, the slow development of effective field-pieces was largely a limitation imposed by the primitive state of firearms technology. Guns were heavy and awkward to manoeuvre, load and operate; their usefulness in pitched battle was thus considerably limited. To argue, however, that "the first man in Europe to appreciate the correct role of artillery in battle was Gustavus Adolphus of Sweden"[20] is perhaps to overstate the case, for at the end of the Hundred Years War, French artillery was not only instrumental in driving the English from their strongholds, but also reversed the victories of Crécy and Agincourt in open battle. At Formigny in 1450, two French culverins broke up the by now time-honoured English formation of dismounted men-at-arms flanked by archers and allowed the French forces to close in, resulting in heavy losses for the English.[21] Two years later, at Castillon, French guns again badly mauled an English force.[22] The Swiss, too, were to be defeated by French artillery, at Marignano in 1515.[23] Mobility was nevertheless the major restricting factor and guns could not become an integral part of battle formation until it was achieved.

Inevitably, the search for mobility led to experimentation with hand-guns. At first no distinction between pieces of differing sizes was made, all being considered as part of the artillery train. The main drawback lay in aiming and firing the piece, for if the user had to hold the simple tube and at the same time apply fire to the touch-hole, there was little hope of a well-placed shot. Two developments were therefore necessary: a more efficient means of holding the gun and a more sophisticated method of igniting the charge. Early 15th-century examples known from various parts of Europe demonstrate clearly the first clumsy steps towards an improved design[24] that enabled the shooter to steady the piece on a fixed rest, or on his saddle if he was on a horse. The invention of slow-match, a nitre-impregnated cord, made firing somewhat easier, but it was development of the lock that permitted the hand-gun to come into its own. First appearing in Germany circa 1475, the lock operated in a manner similar to, and almost certainly inspired by, the release mechanism on a crossbow; by pressing on a trigger, the operator caused a glowing match, held in the jaws of a "serpentine," to be moved down into the priming pan, igniting the charge.[25] The way was now clear for the integration of the new arm with the infantry.

The transition from medieval to modern warfare is reflected in the army that Charles VIII led across the Alps in 1494. In addition to his powerful, mobile artillery, he took with him, true to French tradition, 25 000 cavalry, but 6000 Swiss pikemen and 4000 mercenaries armed with either halberds or arquebuses were included in the infantry.[26] This brave show of might was not accompanied by an awareness that new weapons would require new tactics, and in battle the French relied primarily on pikemen and cavalry. Their opponents in Italy, the Spanish, were, after initial set-backs, quicker on the uptake. Gonzalo de Cordoba, a veteran of the wars against the Moors, realized that only fire-power could break up columns of pikemen and cavalry, and in consequence concentrated on developing a corps of arquebusiers.[27] At Cerignola in 1502, well-positioned small-arms fire played a decisive role in battle for the first time as Cordoba's troops repulsed a French cavalry charge. From then on, the weapon's credentials were firmly established and the Spanish army developed into a formidable fighting force whose tactics were widely emulated. A large square of massed pikemen comprised the solid core to resist charges or press home an attack once battle was joined, but at each corner of the square were musketeers whose fire-power threw enemy ranks into disarray; more lightly armed arquebusiers operated outside the squares as skirmishers.[28] Cavalry, artillery and the rest of the army train were able to operate behind a screen of squares and take the offensive as the situation required. In combining fire-power and shock-troops in one unit, the inherent weaknesses of both arms functioning separately were largely overcome, and the square as a basic fighting unit survived until the 19th century. The ultimate step of the fire-power offered by firearms with the shock and resistance offered by pikes within one element occurred relatively late, made possible by the development of less unwieldy muskets and the invention of the socket bayonet. During the 16th and most of the 17th centuries, pikes and matchlock pieces functioned side by side.

Matchlocks came in a variety of sizes to which initially various names were applied throughout Europe. The two most common matchlocks were the arquebus and the musket. The word "arquebus" appears to have been derived from the German *hakbusche* meaning "hook-gun," which was descriptive of the early hand-guns. In the 16th and early 17th centuries, the term appears to have applied loosely to light guns that could be fired without a rest.[29] "Musket" is derived from the Italian *moschetto* or the Spanish *mosquete*, in both languages meaning, literally, a sparrow-hawk. According to the Oxford English Dictionary, muskets were so named in line with the tradition of naming guns after birds of prey; however, the Random House Dictionary, notes that the term was applied earlier to crossbow bolts. Whatever the etymology, the musket itself was first developed by the Spanish as a heavy hand-gun requiring the support of a forked rest that the musketeer was obliged to carry with him. By the middle of the 17th century, lighter guns were used for which a rest was unnecessary, but the term "musket" was retained to refer indiscriminately to all regular shoulder-arms.[30]

In spite of much experimentation and the early invention of more efficient means of igniting the priming charge, the matchlock musket remained the standard firearm until surprisingly late. That intricate wheel-lock, because of high production costs and its fragility, was not made universally available as an infantry arm is understandable, but the early invention of snaphaunces (prototype flintlocks) did not lead to the rapid adoption of a system that was far superior to the matchlock. Not until the end of the 17th century were the various European armies equipped with flintlock muskets.

With a few notable exceptions, the evolution of fortifications throughout the Middle Ages is best reflected by the defences of castles rather than of towns. The ultimate symbol of feudal power, castles were the territorial markers of kings and their most powerful vassals within which well-provisioned garrisons could expect to hold out as long as supplies lasted, usually considerably longer than besieging forces could afford to maintain sieges. Throughout the Middle Ages, the military advantage lay decisively with the defence. To all intents and purposes, well-constructed fortifications were impregnable.

By the end of the 13th century "the final development of the military architecture of the Middle Ages"[1] had taken place — the origins and evolution of the medieval castle have been detailed by several authors.[2] For the next two centuries only minor variations on the same basic theme were practiced.

In essence, the castle of the 14th and 15th centuries consisted of a masonry enclosure or *enceinte*[3] situated on well-chosen, usually elevated, ground. While the form of the enclosure was often rectangular, as exemplified by some of the best-known castles of the period,[4] this was by no means a universal rule; circular, triangular and irregular works conforming to the terrain were all built. The principal barrier to an attacking force was the masonry wall and hence height was the main consideration, but in order to provide flanking fire and to eliminate dead ground as far as possible, towers were spaced at frequent intervals around the *enceinte*. Design varied, but circular or semicircular towers with their diameters in alignment with the main wall are most frequent. Usually they were multi-storeyed, thereby bringing several levels of fire-power into action through arrow-slits let into the walls at successive heights, and often from an open platform at the top. Access to the towers was likewise made possible at different levels; normally a doorway at the interior ground level led to a spiral staircase which communicated with each level and with the parapet of the curtain walls linking the towers. In some cases the top of the tower was the same height as the adjacent parapet; however, frequently towers were built one storey higher in order to command the curtains. Whichever the case, the heights achieved were certainly impressive. The castle built under the orders of Louis IX at Angers originally had massive circular towers 18 m in diameter rising above the curtains to a total height of 30 m. Even now that the towers have been levelled to curtain height, the *enceinte* still makes the visitor at its base feel insignificant. Curtains and towers were built to the same level in the main part of the castle at Tarascon: an imposing 45 m high.[5] To support such high walls, the masonry had to be thick, usually 3-5 m. In addition, the lower portion of the walls was often scarped to provide even thicker and stronger foundations (the two castles just cited offer good examples of this form of construction). The wide, flaring base also proved beneficial in defence. The additional thickness of masonry made any attempt at undermining more difficult, rams and missiles would not reach the main structure of the wall and scaling ladders could not be brought up to the walls. It has been suggested that such a design was specifically defensive in origin; heavy projectiles dropped from above would, upon striking the sloping base, ricochet off horizontally to smash into attacking forces near the wall.[6] However, it seems far more likely that such tactics were the result of exploiting a structural feature required by building techniques rather than vice versa.

Another means of strengthening walls was the use of buttresses or counterforts, which served also to support arcading which in turn carried the walkway or *chemin de ronde* behind the parapet.

If the walls of the *enceinte* formed the main line of defence, a less conspicuous but nonetheless formidable obstacle was the ditch, regarded as an almost essential element of a fortification except where natural features of the terrain could be relied upon instead. Like the walls, ditches often attained massive proportions: at Dourdan and at Provins the ditches are some 12 m wide and 6 m deep, while at Angers the ditch is 30 m wide and 11 m deep.[7] Even the presence of bedrock near the surface did not discourage excavation of ditches of similar proportions, as at Sedan or at Pierrefonds. Frequently the walls themselves formed the inner, or scarped, side of the ditch, thus effectively lowering the foundations below the surrounding country, and the outer side of the ditch, or counterscarp, was often revetted in masonry to maintain a vertical or near-vertical face. The overall combination constituted a most effective barrier.

It was not unknown for the ditch to be excavated some distance in advance of the *enceinte*, thereby leaving a berm upon which additional obstacles could be raised. In their most elaborate form, such barriers were an outer *enceinte* constructed upon the inner edge of the ditch parallel to the main *enceinte*, reflecting in reduced scale all its features. The finest examples are the so-called "concentric" castles in Wales (Beaumaris, Harlech and Caerphilly) and the fortified town of Carcassonne in Languedoc. Where the outer *enceinte* was continuous, it was referred to in French as a *braie* (breeches or trousers), but if it only extended along a portion of the perimeter, it was known as a *fausse-braie*, a term that was to continue in military architecture into the 18th century. A complete outer *enceinte* was not common and by the end of the 14th century that concept had been generally abandoned owing to the additional construction costs and the problem of distributing a garrison effectively throughout such an extended defensive zone.

Communication from one part of the defences to another was by means of walkways around the perimeter, often at several levels and always including one at parapet heights. One could gain access to the walkways from the interior through the towers or up stairways built against the curtains at different locations. In fortifications where an outer *enceinte* existed, the protected space on the berm, known in French as *les lices* or in English as "the lists," provided an unobstructed circuit around the base of the main *enceinte;* forces could enter or leave it by the main gate or through small postern doors in other parts of the wall.

The main entrance was a heavily defended passageway, usually set between twin towers. Access across the ditch was by bridge, all or part of which could be raised mechanically. Originally operated by windlasses, drawbridges were improved during the 14th century by the introduction of a counter-balance system which enabled one or two men to raise or lower the drawbridge rapidly and easily. Overhead beams, one on each side of the passageway, were supported on pivots at their centres of gravity; the rear of each beam was inside the passage and was heavily weighted. The front portions projected beyond the wall, parallel to and as long as the section of bridge to be raised, to which the ends of the beams were connected with chains. When a slight downward pull was applied to the rear, weighted section, the beams swung into a vertical position and the drawbridge was raised, thus cutting off access and forming a barrier at the same time. While such a design made raising and lowering the bridge easier, allowance had to be made for the beams to pivot freely, and recesses had to be cut into the wall face above the entrance to accommodate them in their upright position. The beams, either protruding in their horizontal position or raised above the entrance, were a prominent and vulnerable feature of entrances to fortified places, yet remained unchanged for centuries. Numerous examples of counter-balanced drawbridges survive in France in varying states of repair: one of the better ones is at the northeast *porte de ville* at Angers, installed in the 14th or early 15th century. There, in addition to the main entrance, a smaller side entrance is also furnished with a counter-balanced mechanism, but only one centrally mounted beam was needed for the restricted opening, which could be used even if the main gate were closed. A similar design is also found at Louis XI's chateau of Langeais, completed in 1467.[8] Entranceways of places built in the 16th-18th centuries also employ the same system virtually unchanged (Fig. 1).

Raising the bridge effectively sealed the passageway, but additional barriers were considered necessary. Immediately behind the drawbridge were large double doors, heavily reinforced with iron, which could be closed regardless of the position of the bridge. The passageway between the towers was vaulted and carried on the vault was a guardroom from which a portcullis could be lowered by means of a windlass. Wider than the passageway, the portcullis fitted into vertical recesses in the passage walls and was thus not easily displaced. Finally, at the end of the passage another barrier or barred gate closed off direct access to the inner courtyard.

Access was further controlled by outworks beyond the ditch in front of the entrances. Anyone approaching the main entrance would first have to pass through an enclosed area known as a barbican, designed as a screen wall commanding the road into the fortified place. While there was little standardization of shape or size, barbicans were frequently semicircular in plan, with the counterscarp of the ditch forming the chord. Where an outer *enceinte* existed, the barbican could be formed by expanding a section of that *enceinte*. These works were often strong, detached forts in their own right with substantial gateways that provided yet another obstacle to would-be attackers.

Fortifications had to serve as more than passive barriers. They had to incorporate the means to permit defenders to discharge missiles against an attacking force with maximum effect. The principal weapon was the bow, either the mechanically tensioned crossbow shooting short, flighted quarrels or bolts, or the simple short bow shooting ordinary arrows. Defenders could operate with relative immunity from behind walls pierced with narrow, vertical arrow-slits which allowed horizontal or near-horizontal fire, albeit within a very restricted field of vision for each individual slit. A broader field, but with a correspondingly greater risk of exposure to enemy fire, was available on the battlements, which consisted of crenellated parapets, usually exposed to the sky. With towers projecting from the *enceinte* at intervals, the ditch and curtains could be reasonably well covered by flanking fire, but dead ground did exist, especially against the very base of the walls. Furthermore, an enemy capable of advancing under heavy screens was not liable to be thwarted by arrows and bolts alone. For this reason, a way of dropping heavy missiles straight down the walls without exposing the defence had to be devised. This first took the form of temporary wooden galleries or hoardings supported in front of the parapet on wooden or stone corbels, missiles being dropped through spaces in the floor.[9] (Viollet-le-Duc's reconstruction of the hoardings around the château of Carcassonne provides a fine example of this form of defence.) The shortcomings of wooden construction led to the replacement of such structures by permanent stone galleries, known as machicolations (Fr. *machicoulis*), which were less susceptible to damage by fire; their incorporation into fortifications had become general by the end of the 13th century.[10]

Security against attack was thus assured by a combination of defensive principles: choice of ground and limited access, wherever possible obliging the approach to be uphill; height of walls to reduce the danger of escalade; fields of defensive fire[11] both horizontal and vertical; well-guarded entrances which could not be easily forced by direct assault or traversed by stealth, and successive barriers such as ditches, palisades, *braies* and *fausse-braies* to put as many obstacles as possible in the way of an attacking force.

Contesting the ground every step of the way was fundamental to concepts of medieval siege warfare.[12] The relatively small numbers of combatants and the limited power of weapons tended to perpetuate the feudal traditions of individualistic, hand-to-hand fighting. For an attacking force to be sure of having taken a place, every pocket of resistance had therefore to be overcome. Unlike the sieges of the 17th and 18th centuries, a breach in the main *enceinte* did not herald the end of the siege, either by assault or by surrender. Even if the breach were stormed, the defenders could retreat to different parts of the fortifications, particularly the towers, and continue their resistance. The desirability of being able to move troops rapidly from one position to another on the walls had to be balanced against the need to place as many obstacles and independently defended points in the way of an attack as possible, so that the fall of one sector did not allow the rest of the defences to be overrun.

In order to take a place, an attacker had three basic alternatives: the brute force of a direct frontal assault and escalade; the more cautious and lengthy method of a systematic investment and siege, or reliance on help from within, either his own forces who had managed to sneak in or traitors whose co-operation had been bought. Not unnaturally, various combinations of all three approaches would be attempted at different times according to circumstances, together with open appeals to the defending garrison to surrender honourably against overwhelming odds.

Given the lack of technological advances, it is not surprising that siege warfare had evolved little from Roman times. Indeed, owing to the lack of large, well-disciplined armies in medieval times, sieges were often conducted less efficiently than previously. The principle was simple enough. Once a place had been cut off from outside help and supplies, the besiegers had to wear down the defence by persistent attempts to break in. This was accomplished by battering the walls with rams or by undermining their foundations, causing them to collapse. The presence of a ditch, especially a water-filled one, rendered the approach of a mine difficult and dangerous, and an open sap was exposed to missiles dropped from the machicolations. Even if they succeeded in reaching the wall, miners might break through between two counterforts which continued to support the masonry they had undercut. Nevertheless, mining was a favoured technique as it was not costly in lives and could produce satisfying spectacular results.

Naturally, while an approach was being tried, every effort was made to drive the defence off the parapet in the threatened sector. Here the missile-hurling siege engines were of use. While the heavy projectiles flung by catapults and trébuchets could not be relied upon to breach the main section of a wall, they could smash down battlements and machicolations, which were of thinner masonry, while charges of smaller missiles could be hailed upon the defenders. Meanwhile, crossbowmen and archers would be pushing forward under cover of heavy shields to shoot at any exposed targets.

The miners, also using movable screens if they could not drive a tunnel completely underground, would advance to the foot of the wall. Their point of attack was usually a sector of curtain between two towers. Gateways, heavily protected by flanking and vertical fire, and furnished besides with multiple barriers, were too difficult and costly to be considered under normal circumstances, while undermining a tower's outer wall did not open a breach in the main *enceinte*. The curtain, although often flanked by towers, was favoured as the most vulnerable area.

When an assault was launched, the attackers crossed the ditch, throwing in materials for a makeshift causeway or bridge where necessary, and rushed the curtain. If a breach had been established by mining or by siege engines, they could scramble over the rubble and into the place, but if the wall was still intact or the collapsed masonry too steep, scaling ladders had to be brought forward. A less perilous method was by using an assault tower, a huge, mobile unit which afforded protection against arrows and crossbow bolts. Built as high as the parapet to be attacked, the tower could be moved forward on wheels or rollers to the wall; the attackers would climb up the back to an assembly platform, lower a drawbridge onto the parapet and swarm across.[13]

Such operations were hazardous and success was not guaranteed even if a praticable breach had been established; the advantage still rested with the defence. Why, then, was it not more logical simply to invest a place and starve the inhabitants into surrender rather than to press an attack? Starvation did contribute to the success of besiegers in several instances,[14] but the longer a siege was protracted, the more costly and complicated it became. To ensure the complete isolation of the place under attack, large forces were required. Ditches and palisades were constructed around the place, reinforced with earthen parapets and, at intervals, earth-filled, wood-revetted redoubts referred to as *bastides* or *bastilles*,[15] and unless these works were strongly manned, there was always the possibility that relief forces could bring in supplies or that the defenders could break out. Organizing and maintaining such large forces, especially in winter, were often beyond the resources of besieging armies, who had therefore to resort to more desperate measures or raise the siege. Nor should the problem created by the constraints of the feudal levy be overlooked: vassals owed servitude to their overlord for only 40 days of campaigning.[16] Serious, protracted sieges were within the capabilities of only the most powerful lords and the monarchy.

Gun Towers: Precursors of Angle Bastions

Medieval fortifications and gunpowder coexisted for more than a century before a radical departure from existing designs of the former was found necessary. The initial response of military architects in England[1] had its counterparts in France and other European countries:[2] provision was made for small cannon to be discharged through gun-ports which were either modified arrow-slits or newly built substitutes in curtain walls and towers. No other accommodation to the new weapons is apparent in defences of the 14th century.

At the same time, heavy ordnance was beginning to change the aspect of siege warfare, and during one of the frequent reversals of fortune in the Hundred Years War, the English were, between 1369 and 1375, driven slowly but surely out of Normandy by French forces using large guns. When Henry V set out to reconquer this territory 40 years later, he relied on his artillery to capture strategic fortified places.[3] The defences of these places were uncompromisingly medieval in character, and when the army of Charles VII turned to the offensive in 1451-53, the English defences were no better able to resist his powerful artillery.

Not until after the Hundred Years War did military architecture begin to reflect a concern for defence against, as well as adoption of, artillery. Even then, no break with the tradition of high walls and towers was considered, while the new castle built by Louis XI at Langeais in 1465-67 is an anachronism, conceding nothing to the evolution of artillery and demonstrating no advance in design over Pierrefonds, built 50 years before.[4] This is all the more surprising when one takes into account the importance Louis himself attached to the new weapons and the development of a powerful royal artillery train. However, several other castles of the same period clearly do reflect their architects' recognition of the necessity of defence against siege-guns.

The dominant feature of Lassay, completed in 1458, is its massive, protruding towers. These are for the most part U-shaped, with the main *enceinte* acting as their rear walls, but at the southeast and southwest corners they are circular. The tower walls are from 2.6 m to 2.9 m thick and the few openings are in the sides flanking the curtains. The towers are 6 m higher than the relatively low — 7 m — curtains they command. True to tradition, towers and curtains are furnished with stone machicolations and parapets. Not until some 30 years later was the barbican covering the vulnerable north entrance modified to take cannon and, significantly, no machicolation was retained there. In addition, a gallery was constructed around the base of the northwest tower protecting the entrance to supplement the fire-power of the barbican.[5]

A better and more imaginative design was chosen for the castle of Rambures, completed in 1470, where tightly grouped towers were clustered together to present a surface difficult to pierce with a direct shot: cannonballs were more likely to glance off the intersecting curves. The walls were 7 m thick and the overall appearance is one of compact power.[6]

The castle of the Duke of Brittany at Nantes, begun in 1466 and completed circa 1480, reflects a similar strength and compactness, and in spite of the height of its walls, is well protected by being sunk into a ditch so that it is quite low in relation to the surrounding country. Furthermore, its towers were modified only a decade later to become powerful gun towers with embrasures flanking the curtains at ditch level.

Throughout the latter half of the 15th century, examples of similar gun towers, either newly constructed or modifications of existing towers, appeared in several countries. One of the earliest in France was the Tour du Connétable, the donjon of the castle of Ham. In a castle of otherwise medieval aspect, this circular tower, with walls 11 m thick at its base, had four firing levels. Three vaulted chambers were pierced with embrasures sweeping the ditch and commanding the surrounding country and an open platform on the roof allowed cannons to be fired through embrasures in the parapet.[7]

Two massive U-shaped (or *fer à cheval*) gun towers were added to the defences of Fougères in 1480, each constructed with five vaulted storeys providing for extensive flanking fire (Fig. 2). The walls are 7 m thick at the base and 20 m high. The width of the towers being equal to the height, the architectural proportions again convey a great sense of strength.[8]

The defences built around the town of Langres at the end of the 15th century are similarly noteworthy for their solidity and capacity for flanking fire. A large circular tower, 30 m in exterior diameter, covers the west entrance with two storeys of vaulted chambers whose embrasures commanded the faces of the curtains to the north and south and also the approach road; from the platform on the roof, additional guns could be fired over the parapet. Elsewhere on the *enceinte*, U-shaped or *fer à cheval* towers, 25 m high depending on the terrain and with 7-m-thick walls, flank the curtains. Vaulted like the great tower, these works allowed forward as well as flanking fire. Each chamber was provided with vents to permit the gun smoke to dissipate.[9]

The northern and central Italian states throughout this period were the scene of much experimentation in fortification architecture, particularly with round and pentagonal gun towers, or tower bastions, as Hale refers to them. Such works appear to have been common from the middle of the 15th century onwards and led logically to the *enceintes* of Brolio, begun in 1484, and Poggio Imperiale, begun in 1487 but never completed, in which primitive bastions in the true sense provide the flanking fire.[10]

Perhaps the finest example of early artillery defences based upon the use of gun towers is the castle of Salses in Roussillon (Figs. 3, 4). One of the penalties Charles VIII paid for his Italian adventure was the ceding of this territory to Ferdinand of Aragon. When it became clear that the French were not content to let this arrangement stand, the Spanish promptly set about ensuring their tenure by constructing a powerful fortress, begun in 1497 and completed in 1503. While unmistakably medieval in its rectilinear plan and round towers at each angle, several features made Salses a formidable stronghold. The walls, strongly scarped at their base, were surrounded by a deep ditch, so that the sunken effect remarked at Nantes is even more pronounced. Today, the crenellated parapets, watchtowers and machicolations apparent in an early 17th-century illustration[11] have mostly disappeared, but it is still clear that only the superstructure was exposed to an attacker. Breaching the masked walls with siege artillery would be difficult unless guns could be established on the counterscarp. The latter, revetted in masonry, had galleries from which defenders could take attackers in the flank or rear if they succeeded in getting into the ditch; furthermore, a network of tunnels stretched out from the counterscarp to serve as countermines if besiegers should attempt to dig their way towards the place. The curtains between the towers, after rising vertically a short distance above the scarped base, were given a convex curve below the parapet, presumably to deflect cannonballs. Each tower was provided with chambers in order to sweep the ditch with artillery fire, and a donjon in the form of a large tower was incorporated into the west curtain. In front of the entrance, the east curtain and the northwest tower, D-shaped detached works were built to curtain height which gave extra protection and flanking fire; access to these was by masonry galleries half-submerged in the bottom of the ditch and from which additional small-arms fire could be brought to bear on enemies in the ditch. Put to the test shortly after it was completed, Salses successfully resisted an attack through the use of explosive countermines.[12] So strong were the defences of Salses considered to be that Vauban a century later was content to lower the parapets and refurbish the tops of the towers as artillery platforms with embrasures as the only improvements necessary.[13]

It was a time of experimentation, of searching for a solution to the problem of defence against the ever-increasing efficiency of artillery and siege tactics. If enlarging the medieval tower both to receive artillery and to withstand the shock of cannonballs was a logical approach, it was not the only one. Events during the closing stages of the Hundred Years War stimulated local initiative in the face of immediate danger: the English commander at Provins in 1432 ordered the construction of a wall encircling the donjon to a height of 7-8 m; the space between was then filled with earth. Thus the ground floor and the base of the donjon were amply protected against artillery fire, while at the same time, the garrison benefitted from a wide platform on which they could deploy their own guns. The work was referred to as "le Pâté aux Anglais."[14] During the famous siege of

Orleans, raised by Joan of Arc in 1429, both sides made use of temporary earthworks (*bastilles* or *boulevards*): the English besiegers in an attempt to secure their lines around the town, and the French in order to cover weak points in the defences. At the south entrance, approached by a bridge across the river Loire, a boulevard "faict de fagotz et de terre" was hastily flung up to supplement the permanent works in that sector. This was the Boulevard des Tourelles, around which the critical fighting of the siege took place.[15]

More significant than such emergency measures was the attempt to incorporate permanent artillery platforms in a place. The castle of Bonaguil is a well-known and frequently cited fortification of the later 15th century exemplifying this approach.[16] First appearances are deceptive: built on a knoll near the head of a gently sloping valley, the walls and towers rise up with no attempt at concealment, such as at Salses, and give every indication of being firmly in line with late medieval tradition, especially as a donjon is included inside the *enceinte* (Figs. 5, 6). However, each angle has a powerful gun tower, the one to the northwest being the largest and most strongly defended. A deep ditch, dug into the bedrock and not immediately evident, protects the north and east fronts, the steep sides of the knoll being adequate elsewhere. The main entrance is in the north wall and is protected by a drawbridge across the ditch and, on the counterscarp, by a barbican in turn surrounded by an outer ditch crossed by another drawbridge. The medieval concepts thus continue: lofty battlements to command the country and to guard against escalade; access designed to be disputed at every turn, and independent points of resistance inside the towers and donjon. But in the towers, cannon loopholes command the counterscarp and enfilade the ditch. The barbican is similarly designed to accommodate artillery and is flanked and commanded by the towers on the *enceinte*. One of the columns supporting the main drawbridge is hollow and contains a chamber provided with loopholes to further enfilade the ditch; it is complemented by a small, U-shaped tower built against the base of the escarp. Without doubt, the most important features at Bonaguil are its boulevards. On the west front is a large, square terrace, revetted in masonry and supported by a series of counterforts; to the east, a low wall parallel to the *enceinte* encloses the southeast and northeast towers in a manner reminiscent of the *braies* at Carcassone. Thus the defenders could deploy artillery on a wide front to east or west, commanding the valley or the only approaches to the castle. Begun in 1445 and completed over a period of 40 years, Bonaguil's strong, well-integrated defences signifies the close of one era of military architecture and the beginning of another. Above all, it is clear that the logical incorporation of the medieval elements of defence, such as the barbican and the *braie*, into fortifications designed both for and against artillery was envisaged in the latter half of the 15th century. Viollet-le-Duc points to the form of the *braie* in the fortifications around the town of Orange, built by command of Louis XI, as a further development in the move towards low, flanked *enceintes*.[17] There the *braie*, instead of running parallel to the main *enceinte*, flared out into angular works capable of providing flanking fire along the low wall from which they projected.

Certainly there was incentive enough for more efficient means of defence to be explored. In France both Louis XI and his most dangerous rival, Charles, Duke of Burgundy, appreciated the potential of artillery and set about accumulating the largest siege-trains in Europe. The final outcome of the civil wars in England would similarly see the concentration of artillery in the hands of the monarchy. To the east, the danger of Turkish expansion had become a constant source of anxiety to the Holy Roman Empire and small states such as Venice since the fall of Constantinople in 1453. That siege has been regarded as the last of the great medieval sieges[18] and indeed the mass assaults and escalades of the besieging Turks relied little on tactics then current in the west; nevertheless, large guns were brought into action against the great walls, so long considered impregnable, and the lesson was reinforced: traditional defences could no longer be considered adequate.

It is not surprising that towards the end of the 15th century a change in military thinking is reflected in a diversity of architectural styles. The traditional methods of defence, relying on height and inaccessibility, were gradually abandoned as artillery power and accuracy increased. Walls had to become thicker and lower, their escarps shielded from the shattering effects of direct horizontal fire, and to guard against assaults on the curtains, the new weapons had to be incorporated into gun towers or low galleries in the ditch itself to provide flanking fire.[19]

The need to accommodate cannon larger than could fit into towers and to benefit from a wider field of fire, at the same time obliging enemy forces to keep their distance from the main *enceinte*, gave rise to expanded boulevards replacing the barbicans on the *braies*. Variations on these themes occurred throughout Europe and into the Mediterranean, as the defences built by the Knights of St. John on the island of Rhodes show.[20] Since it was not until the turn of the century that any treatises on fortification were written, the exact sequence of events culminating in a recognizably new system of defence will probably remain forever obscure; however, it is evident that for at least half a century prior to Charles VIII's invasion of Italy, considerable thought was being given to the need for an adequate response to the threat of artillery. It is generally accepted that a solution which was to dominate the theory of fortification for over 300 years emerged in the northern Italian states.

In an age of great artistic and scientific revival, Italian architects not surprisingly addressed themselves to military concerns and fortification designs, often for aesthetic as much as practical considerations. As early as 1465, Louis XI fortified Paris by "constructing bulwarks 'in the Italian manner', i.e. according to the latest in military architecture."[1] No description of the bulwarks exists, but the comment was made by the Milanese ambassador to the French court, Giovanni Petro Panigarola, writing to his master, the great *condottiere* and Duke of Milan, Francesco Sforza. Both Louis and Charles of Burgundy made extensive use of Italian mercenaries, and Louis seized every opportunity to learn of Sforza's military methods.[2] The interchange of ideas, combined with observations by soldiers, architects and engineers travelling throughout Europe, suggests that fortifications development in Italy drew upon a wider range of experience than was available simply within the geographical confines of what is now Italy. Certainly the gun towers of the citadels at such places as Imola, Senigallia and Nepi[3] stand firmly in line with an architectural tradition common throughout Europe.

The first breaks with tradition occurred when towers were designed to angular or pointed plans as opposed to circular or U-shaped ones, thereby eliminating the dead ground immediately in front of the tower. This was clearly the intent of Giuliano de San Gallo, the Florentine architect who with his brother Antonio was responsible for the construction of some of the most important transitional works. The plan of the fortress at Nettuno, built about 1503, is a square with an angular tower somewhat like the ace of spades at each corner. This design allowed protected flank batteries to cover the curtain while the faces of the bastions could also be swept with fire.[4] In elevation the medieval influence is still strongly apparent: the walls are high with no attempt at concealment and the parapets are machicolated. The towers themselves are no larger than other gun towers and offer little space to deploy artillery.[5] Nevertheless, with the *enceinte* of Verona designed by Michele Sanmicheli and begun circa 1530, and of the Fortezza da Basso at Florence by Antonio de Gallo the younger, begun in 1534, the predominance of the bastioned system of defence was firmly established.[6]

There is a distinct difference between a bastion and a bastioned system. As it came to be universally understood from the 16th century onwards, a bastion was a projecting work protruding from the *enceinte* with the overall appearance of an arrowhead, the ace of spades or a ship's prow (Figs. 7, 8). Its purpose was essentially that of the medieval tower adapted to superior weaponry: to provide the defence with a commanding position from which they could fire upon approaching enemies. The actual form was not revolutionary. Medieval towers occasionally had similar angular projections, and the early 15th-century defences of Mont St. Michel contained bastion-like protrusions. The bastion shape of the barbican at Rhodes dating to 1496 has already been cited.[7] Nor was the function innovative. The boulevards and converted barbicans of the first half of the 15th century were designed to achieve exactly the same effect. The first bastions to appear early in the 16th century — such as the first bastion at Verona: Michele dei Leoni's bastion "della Maddalena" built in 1527 — seem to have been added piecemeal to existing *enceintes* rather than integrated into a system of defence.[8] Significantly, isolated examples began to appear in France at this time too. True to French tradition, Italian influence was strong, and Francis I employed Italian architects and engineers for most of his major construction projects. The great tower at Toulon, the low and powerful Chateau d'If off Marseilles and the tower at Le Havre were all built by Italian engineers in the years 1515-25.[9] These fortifications were built in the tradition of the circular gun tower, but as the new style began to proliferate in Italy, a bastion-shaped work was built by an Italian engineer to protect the Sainte-Croix gate at Bordeaux, completed in 1535.[10] The defences around Troyes were strengthened between the years 1524 and 1530; large, obtuse bastions are identified on a plan of this period.[11] Interestingly enough, both examples are defences erected in front of existing *enceintes* and reflect a concern for protecting gateways. They may therefore be considered to represent the transition of barbican to boulevard to bastion, rather than of gun tower to bastion.

Nevertheless, it was not enough for a bastion to provide flanking fire along the adjacent curtains. To be effective, a defensive front had to be designed so that each element defended and was defended by each other. Only when this principle was appreciated and applied can we talk of a new system of defence. The true contribution of the Italian designers was the planned and integrated bastioned front rather than the bastion as such, and the new front at Verona and the *enceinte* at Florence are the first practical manifestations of this co-ordinated concept. Shortly thereafter, the new style began to appear across Europe, its diffusion being aided and accelerated by the dominant factor of European politics throughout this period, the Hapsburg-Valois rivalry. Consolidated under one ruler, Emperor Charles V, were the widespread territories of the Holy Roman Empire, the vast domains of the Burgundian inheritance, the kingdoms of the two Sicilies, Sardinia, and Spain. The very size and geographical distribution of this hegemony meant that conflict with France was inevitable, regardless of the ambitions Francis I had, like his predecessor, of conquering Italy. Both monarchs, therefore, exploited to the full the latest developments in military matters, and Italian engineers were busy fortifying strategic places throughout their respective realms. It is for this reason that a high degree of uniformity is to be found in the design of fortresses generally, and particularly at this initial phase of expansion. The Italian influence may be seen from Berwick to Crete and Malta, from Vienna to Badajoz, and overseas to the Spanish Americas. In 1531 Charles V began to defend the Franche-Comté with bastioned works at Dole and Gray with the help of Italian engineers; Damvilliers, just north of Verdun in the territory of the Three Bishoprics, was fortified at the same time. Antwerp, the strategic seaport of the Spanish Netherlands, was given a bastioned *enceinte* in 1540. Francis I similarly concerned himself with his northern and eastern frontiers at such places as Le Havre, Landrecies, Dijon and Chalon-sur-Saône. Perhaps the best-known examples of this period are Vitry-le-François, begun in 1545 by the Italian Girolamo Marini, and Navarrenx, in the tiny kingdom of Navarre, built by Fabrici Siciliano between 1543 and 1563.[12]

By the middle of the 16th century, the basic elements of the bastioned system of fortification were well established. In succeeding years, variations and improvements in design were put forward by experts of several nationalities, but the underlying principles remained those which had emerged first in coherent form in Italy; much of the early Italian terminology has been retained in recognizably similar words in several European languages. In order to appreciate the significance of later modifications to the bastioned system, it is worthwhile to examine the basic elements and principles at this juncture.

The projecting, arrowhead plan of the bastion has already been discussed;[13] however, no one design prevailed. Whereas the plans of the defences at Verona and Florence indicate simple flanks joined directly to the shoulders of the bastions, the prolongation of the face at the shoulder to form a protrusion suggestive of an earlobe (hence the name *orillon*) soon became a hallmark of the Italian style. Possibly suggested by the design of Giulano de Gallo's angular towers at Nettuno, bastions with *orillons* supposedly first appeared at Turin in 1536.[14] Nor was the shape of the *orillon* standard: some were rounded, some square, as at Antwerp. The purpose of the *orillon* was to cover the gun batteries located in the flanks of the bastions, which swept the ditch in front of the curtains and replaced the detached casemates. In some instances, *orillons* were elongated to an excessive degree, reaching back almost to the curtain. Candia (Crete) and Valetta (Malta) offer the most striking examples of this tendency (Figs. 9, 10). Clearly, designers were being over-cautious and too defensive. Such an arrangement presupposes a determined enemy irresistibly pushing forward across the ditch to assault the curtain, for only at this moment could guns so concealed be brought into action. The preoccupation with powerful, concealed or retired flank batteries was nevertheless a major factor in fortification design for some time; indeed, some early bastions were designed solely for this purpose, and had only one long, straight face instead of two angled ones.[15] An example may be observed on an early plan of Montmédy: a re-entrant in the curtain is furnished with an *orillon*, presumably to conceal a flanking battery where the length of curtain between bastions is too great (Fig. 11). Even where angular bastions were built, bizarre mushroom-shaped forms are also found on the same *enceinte*, as at Avesnes and Bouchain (Figs. 13-15). In contrast, bastion plans in a treatise first published in 1564[16] are small and so acute as to afford virtually no space for the defence (Fig. 7). Between these two extremes, bastioned works of varying shapes and sizes were gradually added to existing *enceintes* of strategic places or, more rarely, entirely new fortresses were constructed.

Several factors account for the variety within what was basically the same architectural style. The ideal length of curtain separating two bastions was not agreed upon. In determining the distance between bastions for the fortifications of Antwerp, Charles V had favoured following the example of Sanmicheli at Verona, with curtain lengths of circa 500 m.[17] This meant that the front was defended primarily by artillery fire from the flanks, the range being too great for musketry to be reliable. Recognizing that this could mean a considerable waste of powder and shot if only small numbers of the enemy were being fired upon, that guns were slow to load and fire, and that if the flank batteries were silenced, the defence would be deprived of fire-power at the crucial moment, the distance between bastions could be reduced by adding a bastion, referred to as a *piattaforma*, on the curtain in a rectangular work.[18] The fortress of Brouage, built in 1568 by the Italian engineers Belamarti and Bephani, corresponded to this design.[19] Alternatively, a polygonal *enceinte* with bastions at each angle was recommended in Cateano's authoritative work first published in 1559.[20] Practical applications of this approach were manifested at Rocroi and Philippevile.[21]

Equally contentious was the question of the angle at which the bastion flank joined the curtain (the re-entrant angle) and the angle at which the two faces met (the flanked angle).[22] As recommended by Cateano, the re-entrant angle should be 90 degrees and most Italian-designed works conformed to this requirement. The flanked angle would depend on three variables: the angle of the polygon on which the bastion was formed, the distance separating the flanks, and the length of the faces. Hence the flanked angle could vary from acute to obtuse with faces of greater or lesser length according to the local situation. This was no mere exercise in geometry or architectural proportion: this was the practical consideration of construction costs. Masonry had to be found, a ditch dug and earth moved, all consuming time, money and manpower. More important from the military point of view was the effectiveness of the field of fire obtained from the various combination of wall alignments. The purpose in abandoning the rounded tower and boulevard shapes for the angular form of the bastion was to eliminate dead ground, which could not be achieved unless fields of fire were laid out so as to sweep all sides of the bastion. As any guns deployed on the faces could only fire outwards over the counterscarp, flanking fire had to be provided by the flanks of neighbouring bastions. This was difficult with the earlier dispositions of bastions, typified by the *enceinte* of Antwerp. With flanks at 90 degrees to the curtains, optimum flanking fire was restricted to the ditch parallel to the curtain. Moreover, the high risk of damaging the opposite flank increased when the distance between bastions was reduced. Attempts to resolve this issue gave rise to the concept of the "line of defence," conceived of as an imaginary line extending back as a prolongation of the face of a bastion until it intersected the curtain.[23] If the point of intersection coincided with the re-entrant of the flank of a neighbouring bastion, then it was assumed that fire from that flank would pass along the face of the opposing bastion to strike the counterscarp beyond the flanked angle; this was referred to as a line of *tiro che strischia* (Fr. *feu rasant*), perhaps best translated as "grazing fire." If, on the other hand, the imaginary point of intersection fell short of the opposite re-entrant, then fire from the flank would actually strike the face. This line was said to result in *tiro che ficca (feu fichant)*. Under such circumstances, the distance between the intersection and the adjacent flank was initially regarded as a blind spot, and attempts were made to develop a "second flank" or a "curtain flank" by adding embrasures, but the concept was soon generally abandoned as impractical.[24]

The degree to which such considerations had improved fortification theory is best exemplified by Antwerp in the Spanish Netherlands. The town itself had been given a bastioned *enceinte* in 1540. To guard against unrest within the town and to ensure the garrison a place of further resistance, the Duke of Alba invited one of the foremost Italian engineers, Paciotto D'Urbino, to construct a citadel. The work, carried out in 1568, was based upon a regular pentagon with symmetrical bastions at each angle; retired flanks were covered by square *orillons*.[25] It was regarded as a model fortress and widely admired for the better part of a century.[26]

The ultimate expression of the Italian school of fortification was the creation of Palmanova, a fortress-town in the Republic of Venice. Designed by Scamozzi and built in 1593, it was respected by urbanists and fortifications students alike for its well-ordered symmetry,[27] but Palmanova also represents the decline in Italian influence. Paciotto was a practical man, concerned with military solutions; Scamozzi, for all his inspections of fortifications across Europe, was more of an architect and town-planner. From the middle of the 16th century, more and more treatises on fortifications began to appear, written by theoreticians who were concerned with abstract geometric symmetry rather than practical application, and the evolution of the bastioned system no longer remained the exclusive domain of Italian architects and engineers.

The flanking system of flanks at right angles to the curtains and its inherent shortcomings was a survival of the medieval concept of defending the curtain against assault. A similar concern is reflected in the retention of high profiles for the ramparts: by and large, the sunken profile already demonstrated at Salses was not followed. Walls 13-17 m high were not uncommon, leaving a good 5 m of wall unprotected by the glacis.[28] That other essential element of medieval defence — the ditch — was retained both as an obstacle and a source of material for building up the ramparts and filling in the bastions. Ditches approximately 7 m deep and 30 m wide were universally employed. In plan, the counterscarp was built parallel to the faces of bastions at this time, which resulted in a restriction in the flanking batteries' field of fire, a defect corrected by later engineers.

More important was the contribution Italians made to the concept of defence beyond the counterscarp. Bastions projecting forward from the *enceinte* obliged an attacking force to begin their siege approaches at a greater distance than before, but with the development of the covered way, defence in depth became a serious consideration. The Venetian engineer Tartaglia, who published works in 1546 and 1554, is generally accredited with the invention of the *via coperta* or covered way (Fr. *chemin couvert*), a walkway level with the top of the counterscarp and provided with its own earthen parapet to provide cover for the defenders deployed along it.[29] From this position, musketry or arquebus fire could sweep all approaches and seriously hinder an enemy advance. Shortly after this invention, the idea was proposed of expanding sections of the covered way into *places d'armes* where defending troops could assemble prior to launching a counterattack.[30]

Two other defensive works developed by the Italians are worthy of note: the cavalier and the ravelin. The length of the curtain between bastions presented problems of adequate flanking fire. While the definitive solution lay in reducing this distance, another alternative was adopted by raising a gun battery on the curtain. Evoking the image of a rider seated on a horse, it was referred to as a cavalier. Where the danger of command from neighbouring heights threatened, cavaliers were also raised on bastions, and their later application came to be confined to this purpose.

The ravelin, a detached work in the ditch before the curtain (It. *rivellino*, a work which was supposed to reveal an enemy attack) had early antecedents, as the detached U-shaped works at Salses indicate. At first semicircular boulevards (from which the French *demi-lune* was retained as a term), their original function was much like that of the medieval barbican: to protect an entrance on the far side of the ditch. The development of the triangular shape in order that the work could be flanked from the main *enceinte* was a logical extension of the bastioned system. The benefits of an enlarged work covering the curtain, increasing forward crossfire beyond the ditch, flanking the covered way, and serving as a measure of protection for the flanks of adjacent bastions were soon realized.[31]

The construction of the citadel at Antwerp, while exemplifying the Italian school, was also symptomatic of political unrest that was to have significant influence on the development of fortifications. Citadels were double-edged weapons. They could fulfil the role of the medieval castle as a final stronghold where a determined garrison could hold out even if the *enceinte* of the town had been breached. Time and again in the great sieges of the 17th and 18th centuries an attack on the town had to be followed up by an equivalent or even greater effort against the citadel. But often the citadel was built for a different purpose. In the bewildering frequent changes of ownership that occurred throughout the frequent wars in Europe during this period, it was not uncommon for the inhabitants of towns to find that they had become citizens of a nation whose language, customs and religion were alien to them. A garrison of foreign soldiers occupied the place in order to hold it against an enemy who was frequently the inhabitants' former master. Citadels were thus designed with formidable defences towards the town as well as towards the exterior approaches in order to impress, and if necessary subdue, the populace.[32] In calling for a citadel at Antwerp, Alba was pursuing his repressive policies in the Spanish Netherlands that sparked the Dutch revolt and provoked the celebrated Eighty Years War of Independence (1568-1648). This epic struggle attracted the attention of military experts across Europe, and at one stage or another all leading powers were drawn into the conflict, which towards its final stages became indistinguishable from the Thirty Years War as it raged across northwest Europe. The fierce resistance of the Dutch and their eventual victory over the awesome might of Spain led to detailed analyses of the tactics involved and attempts to identify the secrets of their success.[33]

To speak of a Dutch school of fortifications would imply greater uniformity in their works than appears to have been the case, certainly in the initial stages. Inevitably, the influence of the Italian engineers, working for the Spanish and constructing powerful fortresses across the Netherlands, was strong. Marchi, at one time engineer to Pope Paul III and responsible for improving the defences of Rome, began a treatise on fortifications in 1546 which he later completed in Brussels while in Spanish employment; his book was finished in 1565, but not published until 30 years later.[34] He was one of the first to advocate defence in depth based on a variety of outworks in addition to ravelins, and his ideas were first applied by the Spanish at Steenwick.[35] Later, the use of a series of outworks to hinder an enemy approach came to typify Dutch fortifications.

The work of Daniel Speckle, German military architect, whose treatise was published in 1589,[36] may also have influenced Dutch thinking. The Italian school clearly provided the basis for Speckle's various proposed systems and he specifically singled out the Antwerp citadel and the defences of Valetta as examples of the best fortifications extant. He nevertheless suggested some useful improvements to the Italian system. He recognized, for instance, the weakness of high masonry escarps protruding above the glacis, and recommended that above glacis height the ramparts should be of sloped earth fill only in order to absorb cannonshot and to avoid masonry splinters. Several of his proposals concern the outworks, and he strongly advocated forward artillery positions on the covered way together with large, numerous ravelins evenly distributed in front of the curtains and *fausse-braies* in the ditch, elements comprising the basis of many of the defences erected by the Dutch.

Undoubtedly, the main factors influencing the evolution of Dutch fortifications were the limitations of time and money combined with the constraints imposed by the low-lying terrain. If marshy ground or a high water-table would not permit a deep ditch, then a wide, shallow one, easily flooded as required, could be substituted. If resources did not permit the construction of a continuous, bastioned *enceinte* around a town, then a series of ravelins or *demi-lunes*,[37] each flanking its neighbour, could be built in front of the medieval walls. If ramparts could not be raised high enough to screen the buildings of the town from direct artillery fire, then the outworks must be extended into the country far enough to inhibit the establishment of siege batteries able to fire into the town. A water-filled ditch at or near the foot of the glacis was thus frequently employed. More important, the Dutch adapted to their own situation an outwork known as a tenaille, which was probably an Italian invention[38] but first put to practical use in the Netherlands. The term is originally French, meaning literally "pincers"; hence in general terms the imagery is of any fortified work with a re-entrant flanked on both sides and therefore capable of catching an enemy between two fields of fire.[39] At this time the tenaille was a low work consisting basically of two ravelins joined by a straight wall; normally a face and a flank was formed on each side covering the connecting wall.[40] The Dutch found it advantageous to modify this design by giving the work depth as well as breadth: the front of the tenaille was pushed forward on the glacis and the sides extended back to the counterscarp. The elongated, straight sides could be effectively flanked from the main *enceinte*. Depending on the design of the front and the alignment of the sides, various names, descriptive of the overall plan of the work in question, came into general use. The two forms most frequently encountered are the horn-work (Fr. *ouvrage à corne*) and the crown-work (*ouvrage à couronne*). In the former, a tenaille front is formed by two half-bastions, with the two exterior sides of the work extending parallel to each other back to the counterscarp (Fig. 18); in the latter two small fronts are formed by the inclusion of a full bastion between the two half-bastions (Figs. 19, 21, 22). A work in which the exterior sides converged on each other was given the fanciful name "swallow's tail" (*queue d'ironde*) and was usually placed in front of a bastion, from the faces of which fire could effectively sweep the splayed sides. A more complicated version evoked the image of a priest's cap (*bonnet de prêtre*).[41]

Like most early Dutch fortifications, these outworks were simply earthen ramparts surrounded by ditches and were liable to deteriorate rapidly; hence they were constructed only in anticipation of hostilities.[42]

The Dutch, possibly influenced by the effectiveness with which their Spanish adversaries used arquebuses and muskets, were conscious of the importance of small-arms fire in defence and their works were designed primarily with this in mind. Artillery being concentrated in retired flank batteries, the range of a musket was a limiting factor in determining the length of curtains and horn-works. Authorities differed as to what the effective range (as opposed to maximum range) of a musket should be, but it was generally taken to be 120-150 *toises* (234-292 m approx.).[43] These concepts were formalized by Dutch writers at the beginning of the 17th century,[44] at which time Dutch fortifications were considered to be the finest in Europe. The defences of Coevorden and Nimuegen in particular drew admiring attention,[45] while the introduction to the English edition of Marolais' book stated that "the fortifications made in these Low Countries are the strongest, exactest and perfectest which have been made and practised."[46] The best example of Dutch fortifications visible today reflect modifications carried out later in the 17th century, principally by the great engineer Coehoorn, himself a writer of treatises on fortifications.[47] At Naarden, wide bastions with multi-tiered batteries in flanks protected by *orillons*, low masonry escarps surmounted by earthen parapets and a multiplicity of water-filled ditches reflect the style of the later Dutch system of defence. But by that time, the French had become the acknowledged leaders of fortifications theory.

The fascination that several generations of French rulers shared for Italy and all things Italian exercised a profound influence on the political and cultural development of France. During the reign of Francis I (1515-47), the Renaissance flourished north of the Alps; Italian artists, architects and engineers entered his service. The French king's concern with military matters led to the early introduction of Italian-style bastioned defences at various strategic places across the country. With the marriage of Catherine de Medici to the future Henry II, in 1533, and the dominant role she subsequently assumed in French affairs, the Italian influence became more pronounced, even extending to French cuisine.[1] More pertinently, the Italian engineers responsible for siege operations and fortifications construction during the continuing wars with Spain and the domestic upheavals in France (the Wars of Religion, 1562-98) were brought in at her instigation.[2] Thus when circumstances forced the Dutch to rely on their own resources and adapt fortifications to their own needs, the French continued to depend on imported concepts and experts.

In the nine years following the accession of Henry IV (formerly Henry of Navarre, leader of the Huguenots) in 1589, fighting continued as attempts were made to end civil strife and consolidate the kingdom. Maximilien de Béthune, duc de Sully, Henry's long-time adviser and trusted minister, is perhaps best remembered for his role as superintendant of finance in restoring France's economy after so much ruin and chaos, but his contributions to fortification were also significant. Decades of war impressed upon the warrior-king and Sully the need for unified national defence and the importance of strongly fortified places loyal to the monarchy. Sully was appointed grand master of artillery in 1598, superintendent of fortifications in 1602. He had himself directed the model siege ("le siège de velours") of Amiens in 1597 when it was held by Spanish forces, and thus was capable of selecting the most competent engineers for positions of responsibility; prominent among his appointees was Jean Errard de Bar-le-Duc.[3] In Sully's policy lay the beginnings of the French corps of engineers and the French system of fortifications.

His war experience qualified Errard to write his theories on fortifications and to apply them. Unlike so many of his contemporaries and successors, he had firsthand knowledge of his subject and proposed only defensive systems he actually used. His treatise was first published in 1600, with a new edition in 1604, but the most widely read edition was that published in 1620 by his nephew after Errard's death in 1610.[4] His best-known fortification is the pentagonal citadel at Amiens (Fig. 23), but he also added bastions to the medieval castle of Sedan[5] (Fig. 21). As director of fortifications for Picardy, Errard was concerned primarily with the northern borders, and hence other examples of his work appeared at Calais (Fig. 24), Montreuil-sur-mer and the citadel of Doullens.[6] The citadel at Verdun is laid out according to Errard's distinctive design although construction was not begun until after his death.[7]

Although many details of the way Errard laid out his fortifications were judged unsatisfactory by his successors, his work is an important milestone in the evolution of the bastioned system. Italian writers had become engrossed in the question of geometrical symmetry at the cost of military considerations. For the first time, Errard demonstrated clearly the interrelationship between geometry, terrain and defensive fields of fire. The work he published in 1594 was, in fact, a treatise on geometry.[8] Basing his plan on the accepted polygonal figure, Errard was the first to propose that fortifications be designed on the interior of the polygon, the angles of the polygon becoming the extremities of the bastions, which were then developed behind these points instead of on the exterior of the polygon as was the practice in the Italian system. The sides of the polygon thus delimited the outer edge of the ditch, not the main *enceinte*, and the flanks of the bastions could then be arranged to provide the desired cross-fire. He felt it necessary to emphasize the need for a relatively short line of defence, not to exceed 100-120 *toises* (195-234 m), this being the practical range of an arquebus or musket. These weapons were more useful in defence than artillery because they offered higher mobility combined with speed of operation.[9]

For a bastion to adequately resist artillery fire, its angles had to be sufficiently wide to allow a good quantity of earth fill to be heaped up inside the walls. Some writers have interpreted Errard's treatise to mean that he required the flanked angle, the curtain or re-entrant angle, and even the shoulder angles to be 90 degrees,[10] but he was not so dogmatic. While stressing the desirability of a wide, strong, flanked angle, he proposed that the flanked angle should be at least a right angle[11] unless the terrain obliged a narrower angle to be built. Only when the base figure was a regular hexagon was a flanked angle of 90 degrees specified. It is clear also from the plans of works he actually built (cf. Figs. 23, 24) as well as the method given in his treatise[12] that normally he preferred not to follow the Italian and Dutch method of building the flanks at 90 degrees to the curtain. Even relying on *orillons* to mask the flank batteries, Errard favoured a re-entrant of less than 90 degrees, resulting in a method of obscuring the flanks from the country that is unique in his style (Fig. 25). The ability of the flank batteries to fire forward of the ditch and harass an enemy at a distance was thus severely limited, probably the most serious shortcoming in Errard's concepts and certainly the one most frequently remarked upon. Fortifications, however, depend for their effectiveness not only on plan[13] but also on profile. The ramparts Errard proposed were to be approximately 25 *pieds* (ca. 8.1 m) above the natural level of the countryside and surmounted by a parapet 8-9 *pieds* high (ca. 2.6-2.9 m) — high enough to protect a man on horseback. The parapet of the covered way was similarly elevated to permit safe circulation of cavalry. Concerned with a rampart's ability to resist artillery fire, Errard recommended a vertical or near-vertical masonry escarp, preferably of soft stone or brick which would absorb cannonshot better than harder materials would; the wall was to be 7-8 *pieds* thick (2.3-2.6 m) and reinforced on the inside by counterforts spaced at frequent intervals and bearing arches to support the parapet. The earth fill of the rampart[14] was to be tightly packed between the counterforts and then separate layers of fill were to be built beyond the ends of the counterforts so that a firm rampart would still survive a breaching of the escarp. To give further strength to the rampart, which was to have an overall thickness of at least 13 *toises* (25.3 m), Errard recommended planting willow trees, the roots of which would bind the fill (Fig. 26). In time of siege, the trees could be felled and used for firewood and *gabions*.[15] As the ramparts were built up from material excavated from the ditch, there was obviously an interrelationship between the size of the ditch and the amount of fill required. A width of 13 *toises* (25.3 m) and a minimum depth of 3 or 4 *toises* (5.84-7.8 m) were recommended, with the ditch wider in front of the flanked angles by 2-3 *toises* as this was where Errard considered an attack most likely. He felt that making a breach in a straight length of wall would allow the defence to surround the critical point and resist an assault, while attempting a breach in a re-entrant area would expose the attackers to too much flanking fire from the undamaged ramparts to each side. The logical thing to do was to batter both sides of a flanked angle with artillery while approaching the breach with zigzag trenches begun out of musket range. For this reason, the flanked angle should not be too acute or it would collapse too readily; it would also be more difficult to flank effectively. Anticipating an enemy build-up at this point, Errard felt that widening the ditch around the angle would leave more open ground that could be swept by fire. In addition he proposed rounding the counterscarp at the angle in order to exploit an ingenious "bounce-shot" *(tir en bricolle)* technique which discussions with the foremost military leaders of the day persuaded him was highly effective. Even though the assault force might not be directly in a field of fire, shots aimed at the curve of the counterscarp would ricochet around the corner, taking the attackers unawares.[16]

By the same token, *bricolle* fire employed by the enemy could be a threat to the defensive positions in the flank in spite of the way in which they were retired and protected by the *orillons*; hence, breaks in the curtain alignment, as proposed by several Italian writers, or the use of turf and earth fill to absorb shot were suggested as remedies (Fig. 25).

Errard believed that a bastion should not only provide flanking fire, but also be capable of withstanding an assault and provide sufficient space for the defence to retrench in the event of a breach in the escarp. For these reasons, he was opposed to multiple tiers of artillery batteries in the flanks and favoured one casemate, set slightly below counterscarp level, capable of housing two pieces of artillery as well as small arms.

While the first section of his treatise describes the artillery of his day and the usefulness of batteries firing in unison to provide greater shock, bringing down large sections of wall, Errard did not appear to have made full use of artillery in defence as a means of keeping an enemy at a distance. On the contrary, the high ramparts, the retired flanks and the concentration of fire-power in the ditch and along the curtain reflect the late medieval concern with direct assaults and escalades. A similarly medieval echo is found too in the multiplicity of obstacles recommended at entrances: drawbridges, portcullises and additional wooden barriers between which traffic entering a place must rest. Two guardhouses, one in front of the gate by the ditch, the other on the townside in order to watch for trouble on the inside, were recommended. Errard was clearly responding to warfare as he had seen it throughout the French Civil Wars of Religion. Towns and strongholds frequently were taken not so much as a result of regular sieges conducted by large armies, but by surprise assaults of relatively small, determined groups or by treachery from within. Large, well-equipped siege trains were not prominent in this form of warfare.

Thus Trincano, writing more than a century later, gave his opinion of Errard's methods:

> This system, full of basic shortcomings, could pass muster in its own time, when strongholds were only attacked with eight, ten or twelve pieces of artillery, without any parallel trenches or forward positions from which the besieged could be harassed: but today it is not good enough, the flanks are too short and do not expose the ditch and counterscarp to enough fire, the front is too small, the ditch badly aligned, and the constricted, concave flanks and casemates overlook but poorly the faces [of adjacent bastions].[17] (Author's translation.)

With the exception of the citadels at Amiens and Verdun, Errard was concerned primarily with improving existing defences rather than designing entire fortresses; hence, while in theory he used as his preferred example the hexagonal figure and even conceived of polygons with up to 24 sides, in practice he was much more pragmatic. Adapting to the requirements of the local terrain, he would incorporate the existing medieval ramparts into his new defence, using them as a retrenchment behind a lower, bastioned front, as at Montreuil-sur-mer, or make judicious use of outworks or advanced works, as at Doullens. Significantly, many of the illustrations in his treatise show essentially medieval works simply defended by ravelins or *demi-lunes* (cf. Fig. 27). In spite of the concepts of fortification being put forward and the construction being carried out, it would be a mistake to imagine a new wave of military architecture sweeping away all pre-existing systems, with bastioned *enceintes* springing up across the country (cf. Fig. 29). While many fortification terms were in common parlance, Errard nevertheless felt obliged to prescribe the essential elements of fortification; bastioned systems were still a novelty rather than an accepted commonplace.[18] One of his contemporaries, Claude Chatillon,[19] prepared a collection of plans which reflect the actual state of affairs at the beginning of the 17th century.[20] The majority of places illustrated show little development since late medieval times, the principal fortifications being simple curtain walls flanked by round towers. The exceptions are such places as "La tress forte ville et Châsteau de Sedan," plan No. 100, and Châlons-sur-Marne, plan No. 136, "Fortifié de neuf Le 2^{me} Octobre iusques au 30^{me} Novembre 1615 Par Extreme Dilligence." The great era of fortresses was yet to begin.

Despite Errard's contribution to the theory of fortifications, his position as king's engineer and the amount of construction he undertook, the details of his system did not take root. With the exception of the citadel at Verdun, designed by him but not built until after his death, early 17th-century French fortifications reflect the revised Italian and Dutch concepts. While Errard's system was a response to the type of warfare practiced during the civil wars, the ever-broadening scope of the Dutch War of Independence and the Thirty Years War once again claimed Europe's attention. The proliferation of published works must also have influenced the military and political minds of the day. English writers admired the Dutch school; significantly, a French edition of one of the better known Dutch works was published at this time.[21] A book published by a successor of Errard exhibits the same bastioned trace as Marolais and contributes little to the theory of fortification,[22] but does demonstrate the extent to which siegecraft had developed as a technique and explains how to approach trenches from elaborately prepared positions almost as complex as the place under attack (Fig. 30; cf. also Fig. 31).

Of more interest were the contributions of two colourful characters extremely active in the various European theatres of war: the Chevalier de Ville and the Comte de Pagan. As with Errard, the relevance of their writings lies in the fact that both were seasoned campaigners with considerable experience of siege warfare.

The period of centralization and national unity orchestrated by Cardinal Richelieu also witnessed increased activity in the construction or improvement of fortified places on all the vulnerable frontiers of France.[23] The bureaucracy of supervisors and controllers of fortifications was expanded to meet the demand; the importance now accorded to the science of both attack and defence is exemplified by de Ville's lengthy book, which described not only the best ways of laying out a bastioned trace, but went into considerable detail on the rationale and morality of fortifications.[24] Fortresses, he maintained, preserve the liberty of a people and defend the weak. He made the point that was to be so characteristic of the limited warfare of the latter half of the 17th century, favouring sieges

> in order to avoid the devastation brought about by these wandering armies, who destroy everything in their paths like a forest fire ... if opposing forces concentrated on sieges, commerce and agriculture would be uninterrupted, the countryside would not be laid waste, and Justice would prevail as strongly in time of war as in time of peace, everybody could live in peace and quiet in their towns.[25] (Author's translation.)

The theme is repeated as an introduction to the section on attack.

In the details of fortification trace, de Ville contributed little to what was already established and, ignoring Errard's theories, reverted to the Italian and Dutch concepts of building bastions out from the sides of a polygon, having flanks at 90 degrees to the curtain, and favouring an aligment producing *feu fichant* and a second flank (Fig. 33). The well-known fortresses of Palmanova, Leghorn and Turin in Italy and Coevorden, Nimuegen and Flushing in the Netherlands are used to substantiate his argument. Although the concept of the "line of defence" was already established, de Ville was apparently the first writer to employ the term.[26] Like Errard, he reasoned that the governing factor should be the effective range of musketry fire.

Unlike Errard, de Ville did not have the opportunity to put his ideas on defence into practice to any extent. Von Zastrow noted quite simply that no works were built by him,[27] but there are two possible exceptions. A plan of the fortress of Chaumont[28] indicates pronounced re-entrants of the curtains on three fronts, two of which are defended by casemated works as de Ville recommended for such a situation,[29] and the bastions are compatible with his design; a later note on the plan states that this is the "système de de Ville." In addition to the improvements Errard made to the defences of Montreuil, further bastions and outworks were added to the *enceinte* and citadel in the first half of the 17th century.[30] The museum there attributes the bastions built beneath the citadel on the west front to de Ville (Fig. 28).

Of greater interest are de Ville's general observations on fortress location and construction. The essential link between geometric layout and practical application on the ground was clearly emphasized. The danger of commanding heights in the vicinity was noted and various choices of site discussed, with coastal locations or open plains being preferred as good all-round defence and control of access was more easily achieved. Heavy clay soils were recommended for their strength and resistance in rampart-building, just as easily shattered masonry, especially on the parapets, should be avoided.

De Ville appears to have appreciated far more than Errard the use of artillery in active defence. He recommended a relatively low parapet only 4 or 4-1/2 *pieds* high (1.3-1.5 m) and was opposed to embrasures which, he felt, limited the field of fire and were too easily destroyed by enemy fire or even the shock of the defence's guns. He preferred cannon to be mounted *en barbette*, raised high enough to be able to fire directly over the parapet. By the same token, he favoured the use of cavaliers as much as possible to have a superior command of both the ditch and the surrounding country; also, an attacker would have to build up higher siegeworks to counter the fire from a cavalier. Firing from an elevated position would give greater range and at extreme ranges the resultant low trajectory would enable the defence to skip the cannonballs along the ground.[31] Vauban is generally credited with having invented ricochet fire,[32] and de Ville's earlier observations on this technique are therefore worthy of notice.

As did his contemporary, de Fabre, de Ville gave considerable attention to various aspects of siegecraft: clearly, the many sieges in the Low Countries were a fascination. Already the ritual of formal siege warfare, later so scrupulously to be undertaken *en règle*, is apparent, and the eventual surrender of a besieged place was a foregone conclusion in the absence of any outside help.[33] Hence, a siege should be prosecuted efficiently, ensuring that no relief force could enter the besieged place either by force or by stealth, but without pushing the defence too hard: "On doit se contenter de vaincre l'ennemi, & non pas l'exterminer."[34] The ultimate step of taking a place by storm was to be avoided since troops regarded it as their right to pillage a town they had stormed, and would press an attack less vigorously if they knew they were to be denied that right.[35]

More practically, a ransacked town was of little value to the victors. Honourable terms of surrender were much preferred, with the defeated garrison permitted to come out with arms and baggage, drums beating, flags unfurled, *la balle en bouche* and slow-matches alight. Usually some token pieces of artillery were allowed to accompany the glorious defeated, along with wagons for the wounded. Following this happy outcome, the new owners of the town were to set about repairing the fortifications and dispensing justice and clemency in order to encourage loyalty and industry in the civilian population.

Belief in the inevitablity of an eventual victory led de Ville to recommend the most thorough and elaborate siege methods, beginning with the choice of season. Ideally, the place to be attacked should be as full of people as possible and surrounded just prior to the harvest so that starvation would do most of the work. The prompt and efficient encirclement of the place was emphasized, and de Ville envisaged a series of earth forts and redoubts interconnected by trenches just beyond cannonshot. Built in every way in conformity to standard fortification principles, such works often became powerful fortifications in their own right. Spinola's siegeworks around Breda were every bit as strong as the fortress he was attacking[36] (Fig. 31). Another celebrated siege to which de Ville referred from personal experience is that of La Rochelle, the Huguenot stronghold on the Saintonge coast (Fig. 32).

In laying out the trenches and redoubts, de Ville again foreshadowed Vauban in stressing the importance of an efficient corps of pioneers who were of great value in carrying out the long and arduous preliminaries of a siege promptly and effectively.[37]

The approaches were made by pushing forward trenches laid out so as not to be enfiladed by the defence's fire; they should be deep enough to protect a standing man and provided with a parapet stout enough to resist shot from a falconet.[38] At regular intervals, enlarged areas *(places d'armes)* should be provided as assembly points. Where two trenches meet, a redoubt should be built.

To breach a wall with artillery, de Ville recommended either 15 or 18 cannon firing from three batteries roughly 15 to 20 paces apart. If possible, the guns should fire in concert at the base of the wall. Where necessary, cavaliers should be built to silence the cavaliers of the defence: two or three, each capable of housing half a dozen light guns, were preferable to one large cavalier.

In approaching a place, due care was to be taken to overcome the outworks, especially if they were arranged in depth, as practiced by the Dutch, since heavy losses were otherwise incurred by too hasty an attack -- de Ville cites the Spanish losses at Bergen-op-Zoom. A cautious, systematic approach was always preferable, even if the siege were prolonged by several months.

In common with many military exponents, de Ville shared a predilection for explosive devices. That bizarre and inefficient creation of the Renaissance, the petard (on which the user was as often as not hoist) is described in some detail. Essentially it consisted of a bucket filled with gunpowder and covered with a stout plank. The plank was attached to a door, the bucket braced and the charge set off. The force of the explosion was supposed to be distributed evenly by the plank and blow the door in (Fig. 34). As a precaution against such methods of entry, de Ville recommended that the passageway be blocked with *orgues* as opposed to a portcullis: a series of posts were lowered from the guard chamber above the passageway through a matching series of slots (Fig. 35).

Destruction of one post did not clear the whole passageway and if the post were long enough, it would simply slide down to replace the missing portion.

An entire chapter was devoted to mining, then regarded as the most practical and efficient way of taking a fortified place. From a carefully concealed entrance, a tunnel 6 *pieds* high (1.95 m) and wide enough for two men to work side by side was to be dug towards the place. When sufficiently close, it was run parallel to the work to be destroyed. Shafts were sunk from this position and galleries pushed forward until the desired locations reached, at which point chambers were opened to contain the charge. A series of short vertical shafts, descending in steps, was preferred to one deep shaft, as the backward force of the explosion was thus lessened. The science of explosives was imperfectly understood at the time, and means to calculate the desired size of the charge not known. Much wasted effort was spent placing the powder in a chest of thick, heavily tarred planks and then into another one bound in iron, and finally into the mine chamber, which was much larger than the prepared charge as it was thought that this was necessary for good results. To fire the mine, a slow-match was left to burn down to the fuse -- a *saucisse* of tarred cloth filled with fine-grained powder. To introduce the fire into the chest, a hollow tube of wood or metal was used.

As mining was the most effective and feared method of attacking a place, de Ville recommended suitable precautions for the defence: a series of shafts and countermine galleries should be dug below the depth of the ditch and pushed forward as far as possible. From positions at the head of the shafts, listeners should be placed to detect signs of enemy mining; once a mine had been detected, it could be blown by a charge or the gallery flooded or filled with smoke. Hand-to-hand fighting of the most desperate nature could occur if a countermine broke through into a mine where the attackers were working.[39] He also recommended countermining the outworks so that if they were taken by an enemy, the defenders could blow them up. Yet another device, referred to as a *fougasse* or a *fougade*, served as a primitive land mine to be placed in a shallow hole in the ground and exploded at the moment an assault was launched.

De Ville was able to put his ideas on mining to the test in 1639 when he and the superintendent of fortifications, Desnoyers, were responsible for the successful attack on the fortress of Hesdin.[40] Here de Ville is credited with being the first to employ a company of volunteer miners.[41]

Like the energetic de Ville, the man generally regarded as his successor in terms of the evolution of fortification theory was an active campaigner of considerable military experience and reputation. Blaise François, comte de Pagan, (1604-65) began his career at an early age and the loss of an eye at the siege of the Huguenot stronghold of Montauban in 1621 did not quench his enthusiasm. In 1633 he was responsible for the lines of circumvallation around the fortified town of Nancy.[42] At the siege of Suza, he apparently penetrated a weak spot in the defences by scrambling up a path and sliding down a deep slope to take the defenders in the rear, shouting "Voici la route de la gloire! "[43] However, by 1642 he had lost the sight of his remaining eye and was forced to retire. His opinion on the current state of fortifications and ways in which to improve it was published a few years later,[44] exciting wide interest and going into two further editions as well as being translated into German.[45]

While he drew on his own personal experience as well as referring to contemporary events as did de Ville, Pagan confined his attention more closely to the question of fortifications, and his treatise is surprisingly short in comparison with that of his predecessor. Like de Ville, he was not able to make much practical application of his concepts on fortification method; nevertheless, his views were based not only on military experience but also on sound geometrical knowledge[46] and represented something of a departure from traditional systems. Pagan did not hold the general quality of fortified places in high regard, commenting that even the strongest held out for no longer than six weeks.[47] Nor did he feel that the Dutch had provided a solution; indeed, he professed astonishment at the amount of resistance the defenders put up behind such feeble fortifications. He was under no illusions as to the possibility of creating the impregnable fortress, and agreed with de Ville that a properly prosecuted siege could only have one outcome -- the question was how long it took. He simply hoped to at least double the time a place could reasonably expect to resist a siege.[48]

As a general maxim, the essence of defence rested in men, artillery, ramparts and ditches, he believed, but the proportions were all-important: too large a garrison would be costly in food and would eventually lead to too many sick and wounded within a place. Thus command of all fronts by well-placed artillery was the key. The issue was how best to achieve this. He dismissed the reasoning behind the choice of 90 degrees for the flanked angle of a bastion, stating that it was based upon a desire for geometric symmetry rather than on any practical experience of fortification.[49] For the most efficient fire-power, the curtain angles should determine the degree of the flanked angle. His observations had demonstrated that defenders fired naturally along a line perpendicular to the parapet behind which they were positioned, hence he was convinced that the optimum design placed the flank at 90 degrees to the line of defence; all other angles would be determined by this one. Normally the curtain angle would thus become somewhat greater than the 90 degrees found in the Italian and Dutch systems and proposed by de Ville. Pagan popularized the method Errard initially proposed of first establishing the polygonal figure and then developing the bastions and curtains inside its perimeter. Depending on the importance of the place to be fortified, he proposed three classes of fortresses -- the small, the medium and the large -- based on polygons with sides of 160, 180 and 200 *toises* (311.8, 350.8 and 389.9 m) respectively. Under these conditions, the bastion faces could be calculated at 50, 55 or 60 *toises* long (45.2, 26.7, 47.2 m). The intervening curtains would be 50.4, 60.4 and 70.5 *toises* long (98.2, 117.7, 137.4 m). Relying greatly on artillery fire from the flanks as the aggressive element of the defence, Pagan proposed three tiers of flank batteries, each level housing four or five guns (Fig. 36). He hastened to assure his readers that this was not so extravagant in artillery as it might appear, since not all bastions needed to be armed. An attack generally only brought two flanks into action at any one time, so it should be possible to locate the 30 or so guns required by his method and assemble them at the strategic points.

Pagan had little faith in the ability of the defence to resist once a bastion had been breached, and he did not believe that retrenchments, either incorporated in the original construction or flung up at the time of a siege, could achieve very much. They would serve at best as a delaying measure, allowing bargaining to take place prior to surrender. Instead, his "Bastion parfaict" was to be masked with a counterguard,[50] a large but narrow work in the form of a chevron built parallel to the bastion faces and separated from them by a narrow ditch (Fig. 37). The ramparts of the bastion and its counterguard were to be of the same height and thickness, so that if an enemy succeeded in overcoming the counterguard, he would find the bastion intact and would have the same effort to make as before, this time under even heavier fire from strongly held positions. This work was probably inspired by elements of the Dutch system in which a narrow earthen rampart *(sillon)* paralleling the *enceinte* provided an additional obstacle; often the *demi-lunes* in front of the bastions were connected by the *sillon*, as at Ostend.

Pagan used the term *"demi-lune"* in the sense of a triangular work in front of the curtains, and regarded its role in protecting the flanks from siege batteries as essential. On the same principle as his counterguards, he strengthened the *demi-lune* by locating a smaller redoubt within the larger work, again increasing the difficulties of overrunning the whole *demi-lune* at once.

Later authorities found much to be commended in Pagan's ideas, at the same time seeing fit to propose their own modifications to correct his oversights.[51] There was general agreement that three tiers of flank fire caused overcrowding, while debris from the upper tiers was liable to collapse into the lower ones; however, in the only fortifications to which Pagan himself contributed the design was much simpler and multiple flanks were not used.[52] His work should be judged less for the details of his systems than for the general principles he clarified and for the contribution these made to the thinking of later generations of military engineers.

> This system is a great advance on those which preceded it, and we may say in praise of Count Pagan that he was the first since the invention of gunpowder to have had a correct perception of the art of fortification and who had established sound principles which enabled that art to develop from the state of infancy in which it had previously languished; ... he is to modern engineers what Descartes is to geometrists. Without Descartes could there have been a Newton, a Leibnitz? Without Count Pagan, could there have been a Vauban, a Coehoorn.[53] (Author's translation.)

Perfection of the Art: Vauban

The endeavours of Richelieu and his successor, Mazarin, brought about an economically and politically powerful country unified as never before, and when Mazarin died in 1661, the young Louis XIV acquired the position of a powerful and absolute monarch. The nation was about to be embroiled in a series of conflicts intended to expand the French hegemony to the detriment of the Hapsburg, culminating in a war of such unprecedented scope and dimension that Winston Churchill described it as a world war.[1]

By no coincidence, the period closing with the Peace of Utrecht in 1713 was one in which significant changes occurred in warfare, fortifications and siegecraft. Few would contest that in battle, Eugene and Marlborough were the foremost generals of the time, while in the domain of military engineering and sieges, Vauban and Coehoorn must rank the highest. Coehoorn is renowned for the small, mobile mortar that bears his name, his skill in strengthening the fortifications at such places as Coevorden, Bergen-op-Zoom or Namur, his courage and determination both in attack and defence, and his treatise on fortifications, which was translated into both English and French.[2] Ironically, of the many fortresses he built or modified in the Low Countries, none were laid out according to the systems he proposed:

> M. Coehoorn wrote his book before he had acquired that great experience, for which he has been so justly esteemed, one of the greatest engineers that ever was ... his works which are published, althou' impraticable in themselves, and undoubtedly thought so by M. Coehoorn himself, after he was a better judge of fortification, as evidently appears by the towns he fortified afterwards; for if he had thought that his works could make that prodigious defence, which he pretends in his writings, it would be very strange, that he should not have made use of them, when he had an opportunity to do it.[3]

His arch-rival, in contrast, was able to give free rein to his creative imagination on all the frontiers of France, thanks to the vast resources placed at his disposal by the king and Louvois, the secretary for war, and the resultant French system of fortification eclipsed all others long after its principal architect had died. But to the confusion of his successors and later students of fortification, Vauban refused to comply with the tradition of expounding his "system" in an authoritative text: "The art of fortifying lies not in rules and systems, but is only to be found in common-sense and experience."[4] (Author's translation.) He did write in some detail on siegecraft and the organization of a good defence during sieges, although the treatises were not published until after his death.[5]

Vauban's career was so long and active that it is impossible to identify with certainty all the places he fortified or improved.[6] As the important places are all well known and the significant elements of his career well established,[7] only certain aspects will be dealt with in the present context.

The name of Vauban is, above all, associated with the construction of powerful fortresses which exemplified his country's might in time of victory and protected her frontiers during later reversals. It is perhaps a truism now among military historians that this was not the only, nor indeed the most important, aspect of his career; his improvements to siegecraft had as much or more influence on his era. His earliest experience of warfare was at the siege of Sainte Ménehould in 1652,[8] and his advancement to the rank of marshal of France, together with the various financial rewards and other signs of favour bestowed upon him by Louis XIV, were all in recognition of his prowess as an engineer who took places rather than one who fortified them. This point has been well made recently,[9] although earlier writers, eager to undermine Vauban's reputation and to champion an alternative concept of fortification, either damned him with faint praise or were overly critical. Mandar, while acknowledging that Vanban brought the art of siege warfare to near perfection, regretted that in his fortifications he was satisfied by simply correcting a few faults in the system that had already been in use for two centuries and being a bit more intelligent in applying basic principles.[10] A harsher criticism was made by Choderlos de Laclos who accused Vauban of having spent the whole of his career impoverishing France with extravagant but ineffective projects, while having contributed nothing to the art of fortification.[11] Not even General von Zastrow's attempts to demonstrate the superiority of 19th-century German fortification methods dismissed Vauban in such terms.

As with most criticisms, there is an element of truth in the comments. A programme of fortifications on the scale undertaken during the reign of Louis XIV would strain any national budget, but to blame Vauban for this is to ignore the fact that control of the finances lay with Louvois and ultimately the king. Vauban himself had only the power to propose and to recommend. Indeed, he often advised against the construction of places if he felt their strategic value was not worth the cost, or advocated the abandonment of places whose maintenance could not be justified. His ventures into the fields of taxation, colonization and religious tolerance were all motivated by a desire to improve the economic welfare of the country.

The charge that he only made minor modifications to well-established systems and added nothing to the art of fortification requires more careful consideration. From its origins at the beginning of the 16th century, the bastioned system had evolved by trial and error, and a century later, military engineers were still endeavouring to determine the most efficient disposition of the bastion flanks. The systematic application of the principles enunciated by Errard, de Ville or Pagan was not seriously attempted except in those places where they themselves had occasion to work; plans of fortresses up to the middle of the 17th century reveal a motley of indifferent to poor defensive *enceintes*.[12] There was no formal training for military engineers, but some knowledge of fortifications was considered part of a rounded education; consequently, to Vauban's great dissatisfaction, it was common for teachers, usually ecclesiastics, to dogmatize upon a subject of which they had no practical experience.[13] The flamboyant text and illustrations of de Ville's book appear to have aroused greater interest than the more sober, technical work of Pagan, while the former's advocacy of a right angle between curtain and flank could be readily understood. The text Blomfield cited to typify such books[14] merely repeats de Ville's definitions and recommendations, and gives a diagram of Pagan's new theory[15] with no explanation and no attempt to follow his reasoning. Even towards the close of the century, if Pagan's ideas were examined at all, they were rejected as no second flank on the curtain could be established and obtuse angles did not appeal.[16] Significantly, Vauban, who was busy building fortresses on all frontiers at that time, does not merit a passing mention.

In 1655 Vauban was appointed *Ingénieur ordinaire du Roi* and was active in numerous sieges in the Spanish Netherlands during the war then being waged with Spain.[17] In the following period of peace (1659-67) he began his life-long preoccupation with the frontier defences of France, but it was not until Louis XIV embarked upon the first of the wars that gradually engulfed most of Europe that Vauban was able to demonstrate fully his capabilities. The seizing of Flanders in 1667 created the necessity to strengthen fortifications or add citadels at strategic places in or adjacent to the disputed territory; the citadels at Arras and Lille were thus his first major projects, along with the strengthening of other town fortifications,[18] but already the elements that were to characterize most of his fortifications were present. Lille was -- and is -- widely regarded as one of the engineer's finest works and a classic example of a bastioned defence (Figs. 38, 39).

The citadel was laid out on a perfect pentagon, each front (measured from one flanked angle to the next) being 300 m long and the curtains between bastions being half that length. The bastions are large and spacious, with straight flanks set at an obtuse angle (106 degrees) to the curtains in accordance with Pagan's concepts. Not surprisingly, not a right angle is to be seen. The outworks Vauban placed in the ditch before the curtains were innovative. Instead of the *fausse-braie* so widely favoured at the time, he introduced a variant he called a tenaille, not to be confused with the earlier tenaille of Errard. Vauban's tenaille was a low, parapeted work built along the prolongation of the lines of defence from the faces of the adjacent bastions and forming a re-entrant angle where the lines intersected midway along the curtain. The work thus presented an obstacle in the form of a shallow V in front of the curtain, so that an enemy gaining the covered way of the glacis would find an additional area behind which the defence could continue a spirited resistance with small arms. Furthermore, the work masked the base of the curtain and adjacent flanks from enemy batteries. The function of the tenaille was essentially the same as that of the *fausse-braie*, but Vauban had detached the work from the base of the rampart and advanced it into the ditch, aligning it on the line of defence. He thereby achieved more efficient flanking fire, as defenders would be augmenting the fire from the faces of the adjacent bastions instead of simply firing straight out from the curtain. At the same time, he lessened the likelihood of debris from the parapets on the main *enceinte* collapsing onto the heads of the defenders below after an artillery strike. Ironically, de Ville was in favour of *fausses-braies* for just that reason: falling rubble was not spread out across the ditch, facilitating an assault, but was contained at the base of the wall, making the wall that much more difficult to mine. Such a disposition could not, however, have encouraged a very determined effort amongst the unfortunate troops assigned to the *fausse-braie*. Vauban was convinced of the utility of additional defence in this location, and situated tenailles of one form or another in all of his fortresses whenever possible. Muller wrote in 1746 that "tenailles are esteemed so necessary, that there is hardly any place fortified without them, and it is not without reason...."[19]

The question of defence in depth -- of presenting the enemy with a series of obstacles, each of which had to be overcome in turn before reaching the main body of the place under attack -- was clearly under deliberation by Vauban at this time. At Lille he placed a *demi-lune* on each front before the tenaille and the curtain. For greater resistance, each *demi-lune* contained in its gorge a redoubt, separated from the larger work by a small branch of the ditch. As if this were not enough, beyond the 40-m-wide, flooded ditch and the glacis was another wet ditch; in the re-entrants of this advanced ditch on all fronts except the two covered by the town itself were placed seven small *demi-lunes* or *lunettes* in total. Finally, an additional covered way and glacis encircled the entire place.

Lille also exemplifies concern with the profile and construction of his fortifications. For the main *enceinte*, he calculated that an escarp inclined to a batter of one in five would retain the 12-m-high earthen rampart if counterforts spaced at 18 *pieds* (5.8 m) were used and the top of the escarp were 4-1/2 *pieds* (1.4 m) thick.[20] The base of the wall, the angles and the cordon were all in dressed stone, as were the gateways; the revetments were all in brick. In the interior, the buildings similarly were furnished with dressed stone surrounds and brick walls. From the parapets, the defence commanded the tenailles, *demi-lunes*, covered ways and glacis; from the tenailles, the ditch, covered way and rear of the *demi-lunes* could be swept; from the *demi-lunes*, fire could be directed into the advanced works. But in reverse, each successive work masked the next so that only the parapet of the main *enceinte* was visible.[21]

The citadel of Lille was built from scratch on perfectly flat, open ground, permitting textbook symmetry rarely found in Vauban's works. Regular fortifications were held to be preferable as they were equally strong all round,[22] but whereas the theoreticians dealt only with idealized works to which geometric rules could be applied without thought, engineers would more often than not be confronted with an existing *enceinte* to be strengthened or unfavourable terrain to be fortified. Simple geometry was not enough in situations that were, by definition, exceptions to the rules.[23]

Pagan had devoted a whole chapter to designing an irregular fortification. In essence, once the classification (small, medium or large) had been determined, baselines should be laid out according to the lie of the land and polygons or partial polygons established upon them. He cautioned that the angles of the polygons should never be less than 100 degrees or else the resulting bastions would have flanked angles of less than 60 degrees, far too acute to be effective.[24]

Vauban's methods developed from these principles. In designing the new defences for the town of Ath, similar dispositions of fronts to those of Lille were employed on six sides of an irregular heptagon, but on the seventh side, the existing town and walls imposed a modification. The straight curtain in which was set the medieval castle was too long to be treated as a single front, so Vauban constructed a flat bastion around the castle midway along the curtain. An outer ditch was added to this front and a horn-work covered a potential weak point where the River Dendre entered the town.[25]

During the same period, Vauban built the citadel at Arras and improved the town's defences. The citadel was based on a pentagon, but differs from that at Lille in several aspects.

One front faced the town, the flanked angles of the two bastions forming this front being placed on the town walls; the adjoining fronts to right and left were of the same length as the town front, and all three were surrounded by a flooded ditch. The citadel was located on a slight ridge, so that before the remaining two fronts, facing the rising ground, the ditch was dry. Because it was presumably considered more likely that an attack would come along the ridge and take advantage of the drier ground, these two fronts were shorter. Four fronts were defended with tenailles and *demi-lunes*, but the town front was furnished with a *fausse-braie* -- a rare, if not unique, example of Vauban's incorporating such a work into new construction. Its location nevertheless makes his intent quite clear: commanding the town and well-shielded from direct artillery fire, the front was designed to resist, with the maximum infantry strength possible, an assault from the town. Since Arras was a former Spanish possession, Vauban was likely considering the possibility of an insurrection. The most striking difference between Lille and Arras is that at the latter he designed his bastions with *orillons* and retired flanks.

The use of the *orillon* to protect the gun batteries in the flank of a bastion had been common practice for over a century, the intention being to employ the guns primarily at the moment of assault when an enemy force would be swarming across the ditch and into the breach in an adjacent bastion or curtain. The guns themselves were mounted either in casemates, as favoured by the early Italian engineers, or on the more exposed, tiered platforms used by the Dutch and widely recommended by several authorities, including Pagan. Proponents of such concepts saw in the protracted siege of Candia (modern-day Iraklion, on the island of Crete) further justification of their ideas.[26] With the outworks overrun and the bastions ruined, the defence was still able to repel an assault thanks to heavy fire from the still-intact casemates (Figs. 9, 10). Mallet observed modestly:

> What is also noteworthy about the casemates of Candia is that, although not built perfectly, as mine are, they performed so well, so that we may legitimately hope for even greater capacity to resist an attack in places defended by casemates of my design ... which far surpass all that have been built or designed by military engineers to date.[27] (Author's translation.)

The spirited resistance of this outpost of the Venetian Republic against the vastly superior force of the Turkish army aroused Europe's sympathy and Louis XIV even went so far as to send some 6000 soldiers and several engineers to reinforce the defence in 1666, but eventually the weight of numbers told.[28] Nevertheless, the merits of casemates and *orillons* were firmly impressed upon military minds. Vauban drew other conclusions from this siege, but does not appear to have been initially influenced in favour of casemated flanks. While he made liberal use of *orillons* throughout his fortifications for the next 20 years following the designs of Lille and Arras, he rarely used casemates, and then only under exceptional circumstances. Instead, the retired flanks he designed were solid and permitted artillery fire from the parapet level only. Such flanks were built on a graceful arc which permitted the defenders more room to manoeuvre. As a further modification, also to gain additional room, Vauban did not design the curtain as a continuous straight line joining the flank directly; instead, a short distance before the junction, he angled the curtain back slightly. This break or *brisure* kept the entire curve of the flank unobstructed. It is not clear what inspired this design. Muller stated that it was Vauban's only original element, all the rest of his designs being based on the work of the German writer, Dilich, whose publications had appeared earlier in the century,[29] but not even that enthusiastic partisan of German fortifications, General von Zastrow, put forward such an argument. Bastions with curved flanks are not attributable to the Italian school nor the early Dutch, although Coehoorn certainly used them in practice as well as in theory.[30] Possibly Vauban was influenced by Pagan, since the citadel of Blaye was designed by that author, if completed by Vauban, and curved flanks are evident there. Whatever the inspiration, Vauban rapidly introduced this design on all the frontier strongholds of France and it is the one most readily identified with the great engineer. Well-preserved partial fronts still visible at Longwy, Maubeuge and Verdun exhibit the characteristic curved flanks protected by *orillons*, while the *enceintes* of Le Quesnoy, Mont Dauphin, Mont Louis and Blaye are preserved almost in their entirety, the parapet embrasures of the last two being in exceptionally good condition (Figs. 44, 45).

In theory, the *orillon* was designed to protect the flank; in practice, the local terrain often obviated the necessity of such cover. At Longwy and Mont Louis, for instance, the flanks of bastions forming fronts that overlook steep slopes where no siege batteries could be established are straight and have no *orillons;* fronts facing ground more open to attack have curved flanks and *orillons* (Figs. 40, 43). At Mont Dauphin only two fronts have any appearance of regularity, the *enceinte* otherwise following the edge of a cliff and incorporating no bastions, simply a series of breaks in alignment that would permit flanking fire.

Such reasoning does not explain why some fortresses were built entirely with straight flanks, like the citadel at Lille, or alternatively with curved flanks and *orillons* uniformly laid out on fronts, like the citadel at Arras or the citadel built in 1681-82 at Strasbourg. Was the engineer experimenting, not entirely convinced of the superiority of one form over the other? The merits of *orillons* were still being put forward in the next century by several authors,[31] but by then the question had become academic; Vauban did not use them in the latter phase of his career and his successors did not reintroduce them in spite of the fanciful designs that some writers conceived.

Discussion of Vauban's designs inevitably leads to the much-debated issue of his "systems." It is well established that his fortifications may be classified according to three systems; it is perhaps equally well established that the systems were an attempt by later writers to do what Vauban never did -- to lay down hard and fast rules of fortification that any engineer could apply. Lazard has argued against the classification concept at great length, demonstrating that Vauban relied on experience and common sense rather than on rules and systems.[32] Even during Vauban's lifetime, books purporting to explain the true "manière de fortifier de M. de Vauban"[33] began to appear, and a generation later the idea of Vauban's three systems was established as dogma. Above all, the founding of the Corps of Engineers in 1744[34] and the opening of the training school of the corps at Mézières four years later -- projects so ardently advocated by Vauban -- ironically contributed to a conservative, doctrinaire approach to fortification. Cormontaigne, the engineer responsible for enlarging various defences along the German frontier (1728-38), had made copious notes and observations on Vauban's works, and when the directors of the school acquired these, they felt that here at last was a solid basis for instruction. As with earlier systems, those attributed to Vauban could only be categorized on the basis of regular fortifications, whereas the majority of Vauban's works, adapted as they were to the terrain, were highly irregular. All works with recognizable bastions, whether having straight flanks or curved ones with *orillons*, were nevertheless classed in the first system. Within this system considerable variances in the lengths of fronts, curtains, faces and flanks occur according to the dictates of the terrain; Vauban did not decree specific dimensions. The same holds true in profile: the low, earth-topped, tree-lined ramparts of Bergues are adapted to the flat, inundated meadowlands of the Low Countries and bear no resemblance to the multi-tiered effect created by the defences of the citadel at Besançon in the foothills of the Jura.

The so-called second and third systems are more problematic. Was a departure from the conventional bastion trace imposed upon the engineer by local conditions, or was he himself dissatisfied with the capacity of such a trace to resist attack? The fortresses most commonly classified as belonging to the second system are Landau and Belfort; their most striking characteristic was the fragmentation of the *enceinte*. Projecting from the curtains were small masonry gun towers or *tours bastionnées*, while the expansive faces and flanks that typified his conventional bastions were detached from the *enceinte* and placed before the towers somewhat like the face-covers or counterguards Pagan originally proposed. The size of these works, together with the fact that they were designed with true flanks, resulted in their being referred to as *bastions détachés* or *bastions à contregarde* rather than as face-covers. That this was a departure from the norm may be deduced from the description of Landau as a "Ville au Roy et Fortifiée d'une Nouvelle Manière"[35] although Belfort, curiously enough, did not merit the same attention.

Vauban himself did not clarify the issue of whether local conditions or his own dissatisfaction led him to tower bastions. In a letter to Marshall Catinat in 1693 he made the frequently quoted comment that "all of this frontier [Savoy] is so extremely hilly that I was obliged to invent a new system of fortification so take advantage of it,"[36] and to le Pelletier in the same year he remarked

> As these three places [Colmars, Entrevaux and Guillaumes] are situated in hilly country and are all commanded from far and near by surrounding high ground, only the method of fortifying with tower bastions should be followed....[37] (Author's translations.)

His comments -- also notable in that they are two rare occasions when he wrote of a "system" or "method" -- certainly state the grounds for his initial use of tower bastions, but cannot be extended to his continued use of them in other circumstances.

The problem of commanding heights was of fundamental concern to all military engineers and throughout his career Vauban made masterly use of heights when attacking a place. Equally, he made every attempt to minimize the danger when fortifying places where he had no choice of terrain. The use of *tours bastionnées* in the Alpine region was one solution and may be contrasted with his earlier work in the Pyrenees. In the valley of the Tet, on the route from Roussillon to the pass into Spain, lies the formerly Spanish town of Villefranche-de-Conflent, fortified since medieval times and improved by Vauban after his inspection in 1669. Describing the place, he wrote that it was "tightly hemmed in by surrounding high mountains with steep slopes so close that even the most distant was within sling-shot," but because of the sharp inclines and extreme height of the mountains, no artillery could be brought to bear; however, outcrops afforded "positions for musketry, from which anyone showing his nose in the streets could be picked off like a sitting duck...."[38] (Author's translations.)

To afford adequate protection for the defence, the normally exposed parapets were roofed in the most vulnerable sector, the bastions and curtains assuming the appearance of a medieval *chemin de ronde*. At the northeast angle of the town, the parapets of the Bastion du Roy were extremely high in relation to the terreplein they covered, so as to give the gunners manning the embrasures maximum protection. Masonry traverses bisecting the bastions were included to reduce the risk of enfilading fire sweeping across one flank and taking defenders of the other flank in the rear (Figs. 50, 51).[39] This was an ingenious solution, applied as it was to the conventional bastion trace which made little allowance for plunging fire, but faced with very similar circumstances nearly 20 years later, Vauban did not repeat it.

Belfort and Landau are the two fortresses most commonly associated with the second system in which towers and detached bastions replaced the conventional bastion, but tower bastions were actually first introduced a little earlier -- when they were added to the existing *enceinte* at Besançon.[40] There, as at Villefranche, Vauban's task was to improve the existing defences of a town. Its medieval walls were built on the river's edge and were within range of commanding heights. On the limited ground available on two fronts, squat, compact artillery towers were built (Fig. 52). One of the criticisms of Vauban's tower bastions was that they were too vulnerable to artillery fire;[41] the towers at Besançon were commanded by the heights that Vauban was careful to fortify, but if these had fallen into enemy hands, the towers could have been bombarded with ease. It is not likely, therefore, that Vauban considered his towers as offering improved defence against artillery and the local constraints at Besançon may have been the immediate reason behind his new approach. Although the situation at Villefranche was admittedly better, since artillery could not readily be brought into action except in the pass, Vauban surely would have employed tower and detached bastions had he considered them effective alternatives to standard bastions at that time. In the adjacent valley of the Tech, the town of Prats-de-Mollo invites comparison with Villefranche and here, too, Vauban's treatment was conventional. Throughout the entire Pyrenees zone, in fact, whether in the mountains or along the rugged coast, no tower bastions were used, in marked contrast to the fortifications built later in the Alps, such as at Entrevaux (Fig. 53), or even in Brittany at Belle-Isle.

It is clear that after Besançon Vauban favoured further experimentation along the same lines. At Belfort the limitations on design are less apparent and could have been resolved by a series of strong outworks such as Vauban had already used at Arras or Bayonne. The change in approach is even more marked in the defences of Landau where the plan of the fortress (Fig. 54) reveals clearly the archetype of the second system: tower bastions on the main *enceinte* protected by detached bastions or counterguards with intervening tenailles covering the curtains in a wet ditch; *demi-lunes* are located in advance of the tenailles on all fronts, and a wet outer ditch surrounds the place at the foot of the glacis. Two large horn-works in the conventional manner with fronts comprised of two half-bastions with *orillons* and retired, curving flanks are shown south of the town (to the right of the plan). Not shown on this plan, but indicated in details of the different approaches made by attacking forces during the four sieges the place suffered during the War of Spanish Succession,[42] is an outer perimeter of detached redoubts beyond the glacis. These works, shaped like *demi-lunes* and open at the rear so that they would be exposed to defensive fire if taken by an enemy, clearly demonstrate an increased preoccupation with defence in depth, a concern to place as many obstacles in series in the way of an attacker before the main body of the place is reached.

The so-called third system was in fact applied to only one place -- the fortress of Neuf Brisach, designed in 1697 and not completed until 1708, a year after Vauban's death. It was the last major work he designed.[43] The same basic principles introduced at Belfort and Landau were applied: *tours bastionnées* covered by detached bastions (Fig. 55). The differences are in detail only, an additional flank being provided on the curtains by adding re-entrant angles. In plan the *enceinte* gives the appearance of a series of shallow bastions with the towers located at the flanked angles. Casemates were provided in the small flanks thus created. The *demi-lunes* were made stronger by the inclusion of a detached redoubt in each gorge. In profile, the counterguards or detached bastions are seen to be demi-revetted: the masonry escarp is only as high as the level of the covered way. The rampart above is of sloped earth with a line of pickets and a quick-set hedge at the foot of the slope. Detached works beyond the glacis are absent and it is apparent that none were needed (Figs. 56, 57).

Neuf Brisach was an entirely new place, built on the flat, open land that was the old floodplain of the Rhine. No earlier defences had to be considered nor were any constraints imposed by the lie of the land. We must therefore conclude that this was Vauban's statement as to what the ideal fortress should be. If bastioned towers had been created initially in response to local conditions and could be applied with advantage to mountainous terrain, he now judged them to be a desirable means of strengthening the defence even in an open plain.

What was the reasoning behind this modification to the time-honoured bastion system? In the absence of any statement from Vauban himself, we may only speculate as to the cause. Surprisingly, there has been little discussion on the matter, either by his contemporaries and immediate successors, or by more recent writers. Lazard has suggested[44] that Vauban developed his second system as a means of countering the effects of *tir à ricochet* which he had himself perfected. This would appear to be a case of special pleading, as the author in the same breath noted that Vauban first tested the technique at the siege of Philippsburg in 1688,[45] by which time the designs of Belfort and Landau were already drawn. A more generalized conclusion -- that warfare and siege techniques had become more sophisticated -- would nevertheless be valid.

Pagan's hopes at least to double the time a fortress could be expected to resist a siege[46] were not fulfilled, as events during the wars of Louis XIV demonstrated. While fortifications became more efficiently and scientifically defended, with improved flanking fire and more substantial detached works, changes in siege methods tended to neutralize any ascendancy the defence might have gained. Vauban's contributions to this state of equilibrium was not insignificant; his achievements as director of over 50 sieges need to be considered along with the more lasting record of his fortress building.[47] To Vauban may be attributed the formal system of encircling a fortress with three "parallels" -- concentric trenches, interconnected by zigzag saps, dug parallel to the *enceinte* of the besieged fortress, with the innermost parallel pushed forward to the foot of the glacis. Such a disposition, with strategically located siege batteries and *places d'armes*, allowed a large force to advance methodically and with little loss until the covered way could be taken. Inspired by the mole-like advance of the Turkish forces against Candia (Figs. 9, 10), Vauban introduced his concept of attack by parallels in 1673 at the siege of Maestricht.[48] There were further refinements, such as his *cavaliers de tranchée*,[49] parapets that were raised in advance of the trenches and permitted the infantry to command the covered way. Mining, which had changed little since the introduction of explosive mines at the beginning of the 16th century, was refined to an exact science by Vauban, who went into some detail on the subject and the related issue of trench-digging in his writings.[50] However, where possible he preferred to breach a bastion by artillery fire, using carefully aimed volleys from strategically placed batteries to demolish the ramparts, as it was a surer and less risky method than sending in miners, even if less spectacular.[51]

His *tir à ricochet* was another innovation along the same lines. De Ville had earlier observed the way in which cannonballs fired from the ramparts would, at extreme range, bounce along the ground but still be effective. Vauban applied this fact to the attack: a cannonball propelled by a reduced charge could be made to skip along the terreplein of a rampart just as a flat stone can be made to skip on water if thrown almost parallel to the surface. If the guns were aligned with the rampart, the ball would continue until it struck something, and quite possibly would retain enough momentum to continue at dangerous speed even after having knocked over a cannon or a man. From the time this technique was introduced, no long unbroken stretch of ground on ramparts or covered ways could be considered safe; traverses, necessary to provide cover against enfilading fire, now became universally essential (Fig. 60).

The artillery of the day left much to be desired, both in its manufacture and in its use. Complaints against the poor quality of the guns punctuate Vauban's official correspondence,[52] while at the battle of Fleurus (1690), the French guns could only fire one round; no one on the field knew how to reload.[53] Nevertheless, casting technology and production had improved sufficiently to permit large artillery trains to be formed and appreciable numbers of weapons to be present at all sieges.[54] Apart from cannon, mortars played a major role, either lobbing bombs into a besieged fortress or showering the defenders with missiles. Vauban was particulary impressed by the destructive effect of 30 or 40 fist-sized rocks fired as a single load from a 12- or 13-*pouce pierrier*; he proposed making ones 18 *pouces* in diameter which could be loaded directly by wheel barrow.[55] Coehoorn's introduction of the highly mobile grenade-throwing piece which bears his name added another element to the problem of plunging fire.[56]

Nor should the basic issue of logistics be overlooked. By the time of the War of the League of Augsburg (1688-97), belligerents were mobilizing the largest armies Europe had seen. At its largest, the French army neared 300 000 men in arms.[57] The ability to press home an attack on a fortress would be greatly enhanced by sheer weight of numbers even if by nothing else. Tactics also played an important part. Whereas Vauban preferred the methodical, unspectacular approach by carefully laid trenches in order to keep casualties to a minimum, Coehoorn was renowned for his more direct methods.[58]

Such were the prevailing circumstances towards the end of Vauban's career. Sieges had become grim, bloody struggles far removed from the leisurely "military strolls" and *fêtes champêtres* of the 1660s and 1670s.[59] Warfare had changed. Vauban not only refined methods of siegecraft, but also constantly pressed for army reforms to improve the artillery service and to create a permanent corps of engineers. He concerned himself with the infantry too, being one of the earliest to advocate adoption of flintlock as opposed to matchlock weapons, and immediately recognized the implications of the socket bayonet, often attributed to him as his own invention.[60] It is not surprising that he should have continued to seek improvements in the fortifications which were a constant part of his life. Defence in depth and the formidable array of barriers at Neuf Brisach were the result.

Vauban's departures from a more conventional trace were an evolutionary dead end as far as the bastioned system was concerned. The frequency with which Landau changed hands in the War of Spanish Succession (in 1702 taken by the Allies, recaptured by the French in 1703, taken again by the Allies in 1704, and finally recaptured by the French in 1713) demonstrated that no fortress or system could be considered impregnable, and Vauban's successors did not attempt to emulate the second or third systems. Memoranda prepared by engineers shortly after Vauban's death reveal an uncertainty as to what combination of fortification principles would provide the best defence,[61] just as the many published texts reveal a divergency of opinions and attempts by the various authors to promote their own particular concepts. Some, like Valory, expressed a preference for the Neuf Brisach model, and Belidor, dipping freely into Vauban's plans and *devis*, used Neuf Brisach as the ideal for comprehensive, well-thought-out specifications,[62] but such ideas were not put into practice. In large measure this was a direct reflection of Vauban's accomplishments. He had spent a lifetime providing the country with a formidable barrier of fortresses along every frontier and exposed coastline -- a barrier that, in spite of everything, had held. It may be debated to what extent dissension among the Allies and the recall of Marlborough came as a reprieve to France and to what extent the fortifications served their purpose,[63] but the important point to the French was that by the time peace came, their frontiers were secure. The strategic considerations behind the frontier defences were, moreover, determined by the king, not by his engineer: Vauban was there to carry out to the best of his technical ability policy dictated from above. It is true that he knew the necessity for a coordinated, comprehensive defence policy, and wrote to Louvois and his successors frequently on the wisdom of holding or giving up certain places. His oft-quoted "seriously, Monseigneur, the king should give some consideration to establishing his natural frontiers"[64] (author's translation) is often taken to mean that Vauban was the prime mover in this vital issue, but clearly Louis XIV was fully conscious of and actively directed all policy concerned with the national frontiers.[65] Vauban's was the subordinate role and he had to follow instructions regardless of whether or not he was in favour of them. Vauban without Louis XIV could have achieved little; the reverse would be difficult to argue.

Nevertheless, Vauban had dominated the scene for so long and risen to such a prestigious position that there was no question as to whose views would prevail at the technical level. Indeed, we might well rate survival amongst his achievements. In an age when longevity was an exception, he lived an extremely energetic and active life, dying past the age of 70. Like his royal master, he had outlived most of his contemporaries and the succeeding generation. This was all the more remarkable considering the hazardous nature of his profession: many a promising career came to an abrupt end in the trenches. When he died, there was no one of like stature to succeed him. Small wonder that indecision and uncertainty replaced the positive authority dominant for so long. Nor was Louis XIV succeeded by a ruler with the same sense of absolutism and fixed purpose. In the period following the Treaty of Utrecht there was little incentive or money to indulge in extensive fortress building.

History has decreed that Cormontaigne was the successor to Vauban, primarily because his voluminous memoirs on Vauban's work and methods were exploited by the School of Engineers as the definitive text on fortifications that Vauban should have written.[66] Significantly, Cormontaigne did not share the opinions of Valory or Belidor. His recommendations consist basically of strengthening traditional bastioned *enceintes* with counterguards and large *demi-lunes*, supplemented by redoubts in the *places d'armes* of the covered ways.[67] He never designed any new places, but worked only from Vauban's original plans and added detached works to such places as Lille and Metz. The result was the perpetuation of the bastion trace throughout the 18th century, with obstinate resistance to any departures from the tradition[68] and in spite of technological advances in artillery and small arms which made earlier concepts obsolete. This was scarcely Vauban's fault.

The achievement of the engineer and, by association, all French fortifications, gave the country uncontested supremacy in the art, and the so-called "French school" was the approved system included in all military engineering courses throughout the 19th century.[69] Vauban had set standards of uniform excellence to which the Corps of Engineers could adhere in design and construction: selection of building materials, thickness of walls, how to set a turf-revetted slope, how to lay in provisions for a siege -- all could be incorporated into the education of professional military engineers.[70] Adding to this body of knowledge firm rules on how to establish a bastioned trace, defining angles and lengths of walls, the engineers ensured that their profession received official sanction as the authority *par excellence* and at the same time removed all incentive to depart from their established concepts. The bastioned system thus became enshrined as the only acceptable method of fortification for the better part of the 18th century.

Louisbourg: A Historical Introduction

The economic and political condition of France after a half-century of virtually continuous warfare, combined with lack of initiative in military engineering following Vauban's death, resulted in stasis as far as the development of fortifications and the construction of new frontier defences were concerned. The terms of peace ratified by the series of agreements referred to as the Treaty of Utrecht salvaged what was possible from the wreckage of Louis XIV's dynastic and territorial ambitions; it was also the turning point in the fortunes of New France.[1]

Drawn by the apparently limitless wealth of fish and fur, the French had been exploring deeper into the North American continent since the early part of the 16th century. By the beginning of the following century, Quebec and Montreal had become the starting points of expeditions reaching out across the Great Lakes into the prairies and down the Mississippi waterway to the Gulf of Mexico. At the same time, expanding English settlements along the eastern seaboard gradually denied the French access to the Atlantic coast except in the area of the Gulf of St. Lawrence, and armed conflict became inevitable. European military technology thus followed closely on the heels of exploration and colonization, but the essential ingredient of 18th-century warfare as practised in Europe -- a network of strongly fortified towns -- was missing. New France was sparsely populated and its few towns were only lightly defended. For the most part, New France could be characterized as a wilderness with isolated garrisons guarding natural routes leading to the hinterland.

At a time when the potential of New France could have been realized, Louis XIV's priorities remained firmly European, yet the insistence of Chancellor Pontchartrain in retaining fishing rights on the Atlantic coast and ensuring that the islands of Cape Breton and St. Jean (Prince Edward Island) remained French reveals an unexpected, vigorous appreciation of the potential value of the fishing trade. More surprising was the commitment of the French government to strengthen existing fortifications in Canada (at Quebec and Montreal primarily) and to fortify strategic locations on Cape Breton -- a commitment that, despite many complaints and queries over costs, and the vicissitudes of Regency government, was respected until the final collapse of New France in 1759.

The decision to safeguard French fishing interests by formally establishing a colony on Cape Breton followed immediately upon the ratification of the Treaty of Utrecht, and the island, in recognition of its enhanced status, thereafter became known as Isle Royale.[2] Choice of the location of its capital took somewhat longer, and not until 1719 was Havre à l'Anglois, by then renamed Louisbourg, given preference over the two other ports under consideration.[3] A brief summary of the town's history will aid an understanding of the way in which the defences were laid out and modified.[4]

The director of fortifications appointed to the colony was Jean-François du Verger de Verville, a member of the Corps of Engineers. His proposals for the three ports had all been quite similar in approach: a simple line of fortifications linking bastioned redoubts to isolate a piece of land overlooking the harbour. It is clear that already by 1717 Verville had a firm idea of the way in which he would defend Louisbourg, and the instructions he received were in effect an official sanctioning of his project, for which he was then given a free hand. The harbour itself, by virtue of its narrow channel, could be well defended against hostile ships, and in the unlikely event that any did force an entrance, the navigable waters would be completely exposed to artillery fire. Four batteries, one on an islet beside the channel mouth, another opposite the channel on the north shore, and the others on the promontory overlooking the southwest arm, were to ensure the necessary cross-fire (Figs. 63, 65, 69, 70). Verville was also concerned about the landward approaches, and to guard against an attack from the west he proposed to isolate the promontory by a defensive line "en forme d'ouvrage à double couronne": a partial *enceinte* consisting of three fronts, two full bastions occupying the centre and a half-bastion at each extremity, one on the harbour shore, the other on the open coast, forming a double-crown work. The bastion built on the highest point of ground and constructed as an independent masonry redoubt was to be the first priority. The other bastions and curtains were initially to be thrown up as *fortifications de campagne* in earth; only later were the plans modified to include masonry escarps in all sectors. The town was to develop behind the line and the governor's quarters and garrison barracks were to be incorporated in a building extending across the gorge of the principal bastion -- the Bastion du Roy. Thus closed on all sides, the bastion could be held against an attack from an enemy who had broken into the town, and was therefore regarded from its conception as the citadel of the town. Work proceeded slowly, Verville concentrating on the citadel at the expense of the harbour defences until 1723, when he received specific instructions to begin the batteries. Friction between Verville and the governor, St. Ovide de Brouillan, over priorities and authority culminated in Verville's recall in 1725; the engineer who had been sent out the year before to serve as his lieutenant at Louisbourg, Etienne Verrier, now became chief engineer of the town. For the next five years, construction was begun or continued at various locations, so that the citadel remained unfinished for the time. The Island Battery and the shore battery (Royal Battery) were begun, as was the half-bastion on the harbour shore (the Dauphin Half-Bastion). The gorge of this work was closed off by a curved battery, the guns of which complemented the harbour defences.

The town itself was not neglected. As the population grew and a systematic town plan was implemented, government buildings were added: a hospital occupying an entire town block, a storehouse (*magazin général*), and a bakery with an armoury on its upper floor. Residences for the chief engineer and other king's officials were also provided by the Crown. Not until 1733 was Verrier able to turn his attention once more to the King's Bastion, completing the gun platforms and parapets. He had also been extending the defences southwards to the Princess Bastion which completed the original *enceinte*. Between the Princess Bastion and the King's Bastion was the other full bastion of the "double crown," the Queen's Bastion. Construction on this work and the connecting curtains continued with some delays until 1735. The last section of the landward *enceinte*, the curtain wall between the King's Bastion and the Dauphin Half-Bastion, was not undertaken until 1736-37. But before the *enceinte* could be considered properly finished, another major project was initiated by the governor's concerns for the town, undefended to the seaward or east side of the promontory. A new *enceinte* was therefore proposed, one which would be ultimately connected to the original one by defensive works along the shore to north and south, enclosing the town completely. Like the westward-facing defences, the eastward-facing ones were to consist of three fronts with full bastions located in the centre. To the north was to be a simple communication on pilings across the large pond behind a gravel strand near the extremity of the promontory. On the strand itself was to be another artillery battery, adding yet more fire-power to the harbour defences. This battery (Pièce de la Grave) was to be connected with a quay wall following the harbour until it joined the earlier *enceinte* beneath the semicircular battery of the Dauphin Half-Bastion. The quay itself, while primarily designed as a facility for off-loading goods and materials arriving by ship, was laid out as a tenaille front. A long, straight curtain was flanked at each extremity, a parapet surmounted the wall along its entire length, and gun embrasures were let into the flanks. Further fire-power was provided by a spur battery in the shallows beneath the battery of the Dauphin Half-Bastion.

To the south, overlooking the rocky shoals of the coast, the old *enceinte*, terminating with the Princess Bastion, was linked to the new by a crenellated curtain running parallel to the beach and into the right flank and the face of the new, southerly bastion, named for the town's governor, Brouillan. The other full bastion was named in honour of the Minister of the Marine, Maurepas. The possibility of an approach by small boats being made through the shoals was obviously a cause of concern, since a cavalier was added to the rear of the Princess Bastion, thereby commanding the inward-curving beach. A covered gallery with loopholes for swivel guns made up of the left face of the half-bastion.

By 1743, more than 20 years after work had first begun, the defences of the town and the harbour were substantially complete. All land or sea approaches were well flanked, and powerful artillery batteries commanded the most vulnerable sectors. The ramparts were fronted by a ditch, covered way and glacis. Incorporating natural ponds, a considerable part of the ditch was either water-filled or at least marshy. In front of the Dauphin Half-Bastion and for some way along the curtain was a large expanse of water, the level of which could be controlled to some extent by the operation at high or low tide of a sluice in a small dam (*batardeau*) which sealed off the harbour end of the ditch. Because the King's Bastion was located on relatively high ground, with bedrock close to the surface, the ditch in front of it was dry, but drainage patterns, influenced by the excavation of the ditch, produced a marshy area that extended southwards to the coast. In front of the easterly defences the ditch was completely flooded, and the Maurepas Bastion was located in a pond which surrounded the ramparts.

Wherever the terrain permitted, the outer edge of the ditch was delimited by a counterscarp, beyond which were a covered way and glacis. The covered way was enlarged at several points to form *places d'armes*, but no other outworks were included. The main road into the town followed the harbour shore past the Royal Battery, around the shallows of the southwest arm, and entered by way of the Dauphin Gate. The gate was designed in the grandiose style common to European fortifications, with classical columns surmounted by military trophies flanking the royal coat of arms. Guardhouses stood alongside the road immediately behind the gate. The security of the entrance was ensured by the multiplicity of barriers. Approaching from the country, the road led through a passageway in the glacis, which could be closed off, crossed the covered way, and then came to a wooden bridge over the flooded ditch. The final section of bridge was formed by a drawbridge.

Although the Dauphin Gate was the only practical access to the town by land under normal, peacetime circumstances, two other elaborate, guarded gateways were built: the Queen's Gate, in the curtain between the Princess and Queen's bastions, and the Maurepas Gate, between the Maurepas and Brouillan bastions. Three postern tunnels (sally-ports) were incorporated in the defences, one in the left re-entrant angle of the Dauphin Half-Bastion, another in the right re-entrant angle of the King's Bastion, and the third in the curtain between the King's and Queen's bastions. Finally, the Frederick Gate, an ornamental gate of timber with a slate roof, spanned the principal wharf on the quay.

The prosperous community which grew up within the walls and along the harbour, where a *fauxbourg* of dwellings, fishing shacks and inns developed, owed its existence to trade based primarily on the fishing industry.[5] The predominant position that Louisbourg came to command in the Atlantic trading system led inevitably to rivalry with the New England colonies. As the political climate in Europe degenerated into war, the French colonies in North America were encouraged to go on the offensive; privateers based at Louisbourg began to harrass New England shipping, provoking reciprocal action in which the British navy was quick to participate.[6] Expeditions from Louisbourg captured the English fishing establishment at Canso on the northeastern mainland of Nova Scotia in May 1744, and in September unsuccessfully attacked Annapolis Royal, the English town and fort overlooking the Bay of Fundy. These acts focussed attention on Louisbourg and provided further incentives to New England factions pushing for an expedition against the French stronghold. Their motives were inspired more by profit than by fear, as McLennan has pointed out:

> When the British colonies sent out about ten times as many privateers as the French, the latter being vastly less effective, it is not reasonable to believe that New England was seriously dismayed by French privateering or failed, in irritation at her small losses, to calculate her surpassing gains.
>
> These considerations led to the conclusion that ... New England had no real fear of invasion but that the monopoly of the fisheries meant such prospective wealth, the sound business insight in the leaders of her people led to their grasping an opportunity to benumb French competition in the markets of the world. This opportunity presented itself when war existed: Louisbourg was short of provisions, its fortifications weak, its garrison small and mutinous.[7]

These forces, put in motion by William Shirley, Governor of Massachusetts, resulted in an expedition that contained all the ingredients of a Hollywood swashbuckling epic: Commodore Warren, bringing a Royal Navy squadron from the West Indies to assume command of the combined British and Provincial fleet, in contrast with the amateur soldiers of the Provincial Army led by a New England merchant, William

Pepperrell; a landing through the surf on the beaches to the southwest of the town under French fire; the abandonment of the Royal Battery without a shot being fired and its subsequent occupation by New Englanders who turned the guns on the town; cannon and mortar batteries being set up to batter the walls and bombard the town after tremendous exertions in dragging the ordnance across miles of swamp; a party of Provincials killed and scalped by Indians; a naval blockade and chase as a French supply ship attempted to bring relief to the town but was fought to a standstill and captured; a daring night assault on the Island Battery, repulsed with considerable loss to the attackers; siege batteries advancing ever closer despite spirited fire from the defenders and the exploding of guns caused by the New Englanders' over-enthusiastic "double-shotting"; the bombarding of the Island Battery from heights above the lighthouse; and the systematic destruction of embrasures on the Dauphin and King's bastions. The only element lacking was an all-out assault, carrying the place by storm. With the Island Battery effectively out of action, the New Englanders were in fact preparing for a combined assault. Warren was to force the harbour at the same time as a landward assault was launched on the breach established in the Dauphin Half-Bastion, but the French realized the hopelessness of their situation and surrendered. They had held out for 43 days of siege since the first battery was established; the Provincial Army took possession of the town on 28 June, 47 days after their landing.

Euphoria quickly gave way to disillusionment. Throughout the entire siege only 101 New Englanders had been killed, the majority in the abortive attempt on the Island Battery; in the months that followed, some 1200 died of disease in the overcrowded, unsanitary conditions they had to endure during the winter of 1745-46.[8] More concerned with the political equilibrium in Europe than the potential of a North American empire, the British government conceded Cape Breton at the negotiating table. By the summer of 1749 the French were back in Louisbourg.

Not surprisingly, little had been done to the fortifications during the occupation. In an effort to reduce the danger from the nearby high ground which had proved so beneficial to the besiegers, a makeshift cavalier had been raised on the ramparts of the Dauphin Half-Bastion, making use of the rubble from the ruined Circular Battery. The right flank of the King's Bastion, which, next to the Dauphin Half-Bastion, had sustained the worst damage, had been repaired sufficiently to be able to serve as an effective battery. The New Englanders appear to have carried out few other major repairs.

Reverting to the *status quo ante bellum* accentuated the obvious: conflict between England and France for control of North America was inevitable, and Nova Scotia was the battleground. The British, deprived of a ready-made fortified naval base, established Halifax as a counterbalance to Louisbourg. The French, alarmed by the implications of a gradual encirclement, incited their Indian allies to harass the settlers and strengthened the garrison and fortifications of Louisbourg. Troop build-ups began on both sides, and British naval squadrons began to patrol the coast and seize French ships.[9]

The value of Cape Breton had been realized belatedly by the French government, as their expensive and ill-fated attempt to recapture Louisbourg from the New Englanders in 1746 had shown.[10] Now its importance as a centre of commerce and a strategic outpost to New France was reflected in the appointment of an experienced engineer, Louis Franquet, in 1750. Initially responsible for recommending improvements to Louisbourg, he became in 1754 director general of fortifications for the whole of New France as well as Isle Royale. It is therefore ironic that, with the ever-increasing threat of war, so little was done to improve the town's defences. Franquet's report offered two options; the first was based upon correcting faults in the existing *enceinte*, while the second, more expensive, alternative emphasized defence in depth by modifying and supplementing the outworks. The former was adopted, but there were delays in appointing a contractor to carry out the work. In Louisbourg the issue was clouded by that chronic malaise of colonial management, conflicting lines of authority, while at Versailles the indecision caused by the divergent recommendations from governor and engineer was heightened by frequent ministerial changes. Work on the fortifications was to a great extent paralysed.[11] Improvements were essentially limited to strengthening the Dauphin Half-Bastion and gate area, rebuilding the right flank of the King's Bastion, enlarging the ditch in front of the curtain between the Princess and the Queen's bastions, transforming the *place d'armes* there into a *demi-lune*, and adding a counterguard in front of the Princess Bastion. War was declared between the two powers in the spring of 1756, by which time Franquet, fearing an attack at any moment, concentrated on raising field fortifications along the coastline at the most likely landing places.

The second siege was in many respects a re-enactment of the first, albeit on a larger scale and with a professional cast. An audacious landing under heavy fire was again effected on the beaches west of the fortress (8 June 1758); siege batteries were established, often on the same vantage points as earlier ones, and the systematic, ruthless pounding of the place into submission began.[12] A spectacular climax to the events was reached with the burning of all but two French men-of-war in the harbour. Demoralized and in desperate straits, the French surrendered 49 days after the landing and following 37 days of heavy bombardment.

There was to be no repetition of the events following the Treaty of Aix-la-Chapelle. Regardless of any possible exchanges of territory at a future peace conference, Pitt was determined that the French were to have no stronghold on the North America coast: "The King is come to a Resolution, that the said Fortress, together with all the works, and Defences of the Harbour, be most effectually and most entirely demolished...."[13] The work was carried out that year.

The fortified towns of Canada continued to expand as urban centres after the British conquest, and the original structures suffered in consequence. No trace of the fortification walls of Montreal now remain, while those of Quebec City, repaired, modified and maintained by the British army for over a century and then stabilized as a promenade around the town once their military function had ceased, bear little resemblance to the original. Louisbourg, by contrast, was abandoned except for the occasional dwelling, and the small fishing community of English and Scottish settlers that became the modern town grew up along the north shore of the harbour, away from the French town. The site, falling gradually into ruin and growing over with grass, was largely undisturbed by subsequent development and became an archaeological time-capsule reflecting a short but intense occupational span (Fig. 110).

Recognizing the historical significance of the place, the Canadian government designated it a historic site in 1928 and created the Fortress of Louisbourg National Historic Park in 1940. In 1960 the ambitious concept of "restoring" the town was put forward and approval was given by Parliament to initiate a modified version of the project; the aim was to "restore" a major portion of the town and its fortifications to a state representing their appearance during the French régime.[14] A full assessment of the present programme would be as fascinating as the study of the original French achievements, and an objective evaluation a worthwhile contribution towards an appreciation of the difficulties and responsibilities entailed in preserving our cultural heritage. Such analysis is outside the scope of the present work, but inasmuch as the course of modern events has had a direct impact on the research process and its results, as expressed in construction or exhibits, reference will be made to particular cases. Despite escalating costs and ever-extending deadlines, the Canadian government stood by its commitment, very much as its 18th-century French counterpart had done, and provided the funds that enable the reconstruction programme to continue. Despite the constraints inherent in the requirement to sustain a largely construction-oriented endeavour, the historical and archaeological research carried out during this period would not have been possible without this commitment.

Choice of Site

The reasons for choosing Louisbourg, as opposed to other harbours on Cape Breton, once it became clear that Placentia (Newfoundland) could no longer remain a French colony, are not self-evident. That the French authorities were concerned primarily about safeguarding the fishing industry was stated in the original instructions from Pontchartrain to L'Hermitte in 1713; the Placentia inhabitants were to be relocated in a port that could be defended, was within easy reach of the fishing grounds, and suitable for landing and drying the catch.[1] Of the three most propitious areas -- Port Toulouse (modern-day St. Peters), Louisbourg and Port Dauphin (modern-day Englishtown) -- initial reports favoured Port Dauphin, and the official position was made clear to Verville when he was instructed to prepare estimates for fortifying all three locations:

> [Louisbourg] would have been made the principal establishment if the port could have been easily fortified, and if there had been a large enough gravel strand on which to dry the catch from the fishing vessels, but the meagre strand there, together with the enormous costs required to fortify this port safely, made the late king, in response to requests from the officers of Isle Royale and merchants of the kingdom, decide upon Port Dauphin as the principal establishment ... the Council wishes to make the Sieur de Verville aware that as far as his fortification designs are concerned, it is not acceptable to fortify in the colonies to the same extent as in Europe because of the great cost....[2] (Author's translation.)

By the following year the members of the council had reconsidered and declared Louisbourg to have priority. Verville was to proceed upon the lines he had already recommended for fortifying the harbour there. In a letter to Costebelle and Soubras, governor and *commissaire* of the new colony, it was stated that

> His Majesty has decided to begin the fortifying of this island at the port of Louisbourg, it being the most important port in terms of its advantages over the others for the fishery and because of its location.[3] (Author's translation.)

The decision was influenced by commercial rather than military considerations, but Verville can scarcely be held responsible on the basis of his report of the year before.[4] The engineer was careful to adhere to his instructions and draw up proposals for the three sites, even finding time to consider a fourth possibility, Baye Royalle, just south of Port Dauphin. While noting that the harbour at Louisbourg "according to the feeling of the merchants and fishermen appears in this respect the best on the island,"[5] his overall recommendation for Port Toulouse appears to have been more favourable:

> Because of the lie of the land, well suited to being fortified, by the difficulty of forcing an entry into the port once the channel markers have been removed, because of the fertility of the land and because it is close to Acadia with its fishing grounds, this port is one of the best locations on the island.[6] (Author's translations.)

The fortifications proposed for all locations were similar, consisting of masonry *redoutes bastionnées* and field fortifications combined to isolate a small section of coastline. Comparative costs showed that Louisbourg would be the most expensive to establish, followed by Port Toulouse and then Port Dauphin.[7] In opting for Louisbourg, the council was committing the government to the most expensive choice, one which their subsequent decision to improve the field fortifications by revetting them in masonry was to render even more costly.[8]

If Verville cannot be criticized for encouraging the selection of the Louisbourg site, his report may be questioned for what he did not say. His comments on Port Toulouse reveal that a tenable defensive position was something to which he attached importance, but at Louisbourg his main preoccupation was the harbour: the Royal and Island batteries originated with his initial proposals. He felt that the landward side was relatively safe as no landings were possible and sufficient command of the nearby knolls could be achieved by the construction of "une forte Redoute Bastionnée exécutée en maçonnerie...." By the following year he revised his ideas of coastal security:

> I was assured that an assault landing on the beach at Louisbourg was impossible at any time and that there would be no need to fortify it.
>
> We came ashore at five places in a single morning, it is wise to examine closely what one is told in America.[9] (Author's translation.)

Curiously, there is little evidence that he initially considered the terrain from an attacker's point of view. Once alive to the possibilities of an attack overland, and given the authority to proceed with the fortifications, he concentrated on the landward fronts to the exclusion of the harbour defences until specifically ordered to remedy his oversight,[10] but his original choice of ground was poor. Superficially, the proposed *enceinte* looks reasonable: the main redoubt is located on the highest point of land, the other redoubt, initially to be a fascined earthwork, occupies another hillock, and the extremities rest on the coastline and harbour shore respectively (Figs. 66, 67). The partial polygon enclosing these works was large and not quite regular, each angle being obtuse and not identical. The two regular bastions were wide and well proportioned, but the plan of the promontory on which the three fronts were laid out indicates the engineer's dilemma. To the south, beyond the point where the *enceinte* joins the coast, is Cap Noir, itself dominated by a rocky eminence with a dangerous command of the Princess-Queen's front. More serious is the rising, broken ground to the northwest. There a series of low knolls overlooks the Dauphin Half-Bastion -- where the fortifications join the harbour-front and the main entrance to the town was located. Not only did this provide an ideal location for gun batteries to fire against the King's-Dauphin front and the whole town, but it also provided a considerable expanse of dead ground, seriously reducing the effectiveness of defensive fire from the King's Bastion.

To have advanced the line of fortifications to incorporate these dangerous sectors would have created more problems. The two knolls chosen as the foremost points of the double-crown work[11] were well to the rear of the high land at each extremity: to abandon them in order to base the extremities on the heights at Cap Noir and in front of the Dauphin Bastion would mean setting a major portion of the defences in low-lying, swampy ground and greatly expanding the total area. To maintain the two central knolls but to swing the extremities forward would create an unacceptable re-entrant in the *enceinte*, with long curtains exposed to enfilading fire. Excluding the possibility of relocating the entire alignment, the alternatives would have been along the lines of Franquet's 1751 proposal to establish detached works on the commanding ground, but would have been a solution confined to the immediate environs.

What surprisingly few of the site plans indicate -- and none with any real accuracy -- is the extent to which the ground rises from the shore. Verville does not appear to have attached any importance to this serious shortcoming nor to have reflected on the dangerous degree to which his plan left the town exposed. The very fact of locating the King's Bastion on the highest point of the *enceinte* meant that the fortifications would have to slope away on each side, particularly so in the sector of the King's-Dauphin front. Viewed from across the harbour, the town, its streets rising towards the King's Bastion, lies completely unprotected, the King's-Dauphin curtain is vulnerable to enfilade, and the right flank of the King's Bastion is not screened by its glacis (Fig. 256). Perhaps with the advantage of hindsight, Jean-Pierre Roma, evaluating Louisbourg's role as a fortress after it was returned to France in 1748, succintly outlined its weaknesses:

> It is a place shaped like an amphitheatre commanded by several heights from which it can be raked with cannonballs and musketry so effectively that no one is safe there, either in the houses or in the streets.[12] (Author's translation.)

Capping this unfavourable situation was the Royal Battery. Located at the water's edge midway along the north shore of the harbour, it was designed to complement the harbour defences by commanding the channel should any hostile ships successfully run the gantlet of the Island Battery's cannon. For this function it was theoretically well located. Equally, however, it was superbly located to fire directly into the town, albeit at extreme range and not with all of its guns. It was itself commanded by a nearby ridge of high ground and had little effective defence to the rear.

By concentrating on the immediate vicinity of the town site and the landward defences, and by not bringing out the problems caused by the downward slope to the Dauphin Half-Bastion, Verville conveyed an impression of a better defensive position than was actually the case. The Council of Marine and the Corps of Engineers' committee were probably not even aware of the dangers of Roma's "amphitheatre" effect.

This effect is most pronounced from the ridges which surround the harbour and command the fortress from a distance of some two miles. The elevations entailed are relatively low; at the highest point the ground is not more than 61 m above sea level, and drops in a series of terraces until the harbour shore is reached. To the southwest the ground levels off into an extended marshy plain (Plaine de Gabarus) of which the peninsula of Louisbourg is a part. The ground here is only 0.35-4.5 m above sea level except where glacial activity or outcrops of bedrock have resulted in small knolls. The knoll chosen for the site of the King's Bastion was no more than 13.7 m above sea level, while the hillock on which the Queen's Bastion was built was 12.2 m above sea level.[13] Several high points ranging between 9.1 and 13.7 m above sea level are within close range of the fortifications (Fig. 68).[14]

Choice of the ground was less than propitious. While it is true that for Franquet a choice of location no longer existed, he appears to have had an unjustifiable confidence in the capacity of the ground to discourage would-be attackers, even when he knew of the events of the first siege:

> The ground in front consists mainly of rock of a kind which creates almost insurmountable problems to an approach by way of trenching, from which I conclude that, by carrying out the proposed improvements [raising the glacis, placing more traverses on the covered way, and enlarging the *places d'armes*], any enemy will only be able to advance an attack on the above-mentioned three fronts [those facing landward] with great difficulty and with all the preparation and procedures of a formal siege.[15] (Author's translation.)

The location of the town was thus not given the fullest attention by the engineers responsible for its defences, both at the beginning and, more incredibly, after the ground had proved unsafe. In fact, if not hopeless, the whole position was, to say the least, a challenge to a military engineer. Because of the amphitheatre effect, construction of detached works on the nearby knolls would not have entirely solved the problem of commanding fire: the encircling ridges would have been ideal locations from which to cannonade such redoubts as well as the main *enceinte*. Moreover, other circumstances militated against the choice of Louisbourg. Verville had revised his opinions concerning the possibility of landings along the coast. Had he given more time and thought to local conditions, he might also have recognized the problems of building on a low spit of land jutting out into the Atlantic. Destructive gale-force winds can sweep across the exposed site, lifting roofs and smashing boats; heavy seas can tear out huge sections of the shoreline and flood the low-lying land; coastal fog can create a chilly, damp micro-climate in which the drying of mortar becomes difficult. The next 20 years were to reveal the extent to which climate combined with poor materials to cause continual frustration and misery to the builders. While access to the fishing grounds was of prime importance to the French, Louisbourg was not necessarily the only logical choice, Port Toulouse being much closer to the rich Canso banks. We are left to conclude that if Verville did not actively recommend Louisbourg over other possibilities, he did not prepare his report with the thoroughness his training should have demanded. Beyond this lies the question of his judgement as an engineer, which was constantly questioned by the governor to the extent that he was eventually recalled. He had proposed lines of fortification similar to Louisbourg's for Ports Toulouse and Dauphin, which he felt were naturally defensible, but which were also commanded by higher ground. Granted that the likelihood of a serious attack was considered remote at the time, there is little justification for ignoring such a basic concept of fortification.

Yet in essence Verville's proposals for defending Louisbourg went unaltered. The only major modification was the addition of the front comprising the Brouillan and Maurepas bastions and its communications to the original defences, but this did not entail the alteration of any of the works Verville had proposed. The weakness of its defensive position being unsuspected or ignored, Louisbourg was judged more than adequate to fulfil its role as a base for the fishing industry.

Physical Environment

Initially, the terrain must have looked very much like the undisturbed coastal zone of present-day Nova Scotia: low hills covered for the most part with scraggly, stunted fir or spruce trees rising above innumerable lakes and streams, or open patches of swampy ground upon which heather, pitcher-plants and other vegetation capable of flourishing in the acidic, poorly drained soil grow in profusion. The earliest known view of Louisbourg Harbour[16] (Fig. 65) depicts just such a scene, with the forest almost to the shore in most areas. The area to be occupied by the town and fortifications is shown as being already partially cleared: the displaced settlers from Placentia had begun establishing themselves there, as evidenced by the numerous habitations and fishing wharves all along the harbour shore. The defences Verville proposed were already under consideration, at least in the eyes of the artist, who showed the hills which were to be the sites of the bastions clear of trees and marked by tall poles. Subsequent activity on the site necessarily altered the ground considerably as the ditch was dug and the original hillsides were modified to accept the ramparts, but in the course of archaeological excavation, natural soil horizons and old land surfaces were exposed, enabling a comprehensive picture of the pre-occupation landscape to be formed.

In the immediate area of Louisbourg, underlying bedrock is predominantly Proterozoic (Pre-Cambrian) -- metamorphosed sedimentary rocks classified in the Forchu Group and comprised of volcanic tuff and acidic lava, breccia, shale and sandstone. Later inclusions of softer strata deposited in basins in the older rock have largely been eroded away, causing lakes to form and creating coastal indentations such as Louisbourg Harbour.[17] Weathering and glacial activity have produced a stony parent material of glacial till from which, in turn, the local soils have developed. Deposited by the retreating ice-fields of the last glaciation, the cover varies from a few centimetres in depth to some 6 or 7 m in moraines or hollows in the bedrock. While the basically unaltered parent material is colloquially referred to as "pink clay," it is far too coarse to be classified as such, and deposits of true clay which can be fired are rare in the area, the nearest ones being on the Mira River. The subsoil is more correctly a sandy loam, as are the soils that develop from it, but poor drainage and high rainfall cause it to be heavy and sticky when excavated, whence the popular designation. In its undisturbed condition, it is hard and compact when dry because of the pressure exerted by the ice, but once excavated and redeposited, it lacks cohesion. Moreover, the quantity of inclusions is high, apart from the basic sand constituent: particles range from gravel (particles 2-7.5 mm in diameter) to cobbles (7.5-25 mm) to stones (over 25 mm) and huge glacial erratics. Bedrock close to the surface is affected by weathering and disintegrates rapidly into shaly fragments. Excavating in such material is no easy task and the resultant fill is less than ideal for constructing earthworks.

It is scarcely surprising that the topsoil is of poor quality. Podzolization occurs to varying extents throughout the area, the majority of soils being classified as gleyed podzols of the Mira Series, formed by imperfect drainage of constantly moist soils.[18] The leaching of minerals from just below the surface by the steady percolation of rainwater and their redistribution lower down give the soils of the area a colourful and highly distinctive profile. The surface or L-H horizon (fresh litter and decomposed organic material) formed beneath the vegetation cover is dark brown to almost black and peat-like in texture. Rainwater turns acidic as it percolates through this horizon so that the underlying Ae horizon is almost totally leached out and presents a light grey to almost chalk-white appearance. The top of the B horizon is stained yellowish brown by redeposited iron. Present intermittently in this horizon at Louisbourg is a true iron-pan: a hard, brittle band only a few millimetres thick and so dark as to appear almost black, as opposed to the more diffuse iron-enriched zone which is sometimes referred to erroneously as an iron-pan. As the effects of weathering and percolation become less apparent, the colours of the B horizon become a more muted pinkish or greyish brown and merge into the C horizon, essentially unaltered parent material.[19] Where a complete soil profile has been buried intact, the original surface is thus readily identifiable, given a basic understanding of the soil horizon. Discovery of the dark L-H horizon immediately on top of the greyish-white Ae horizon did cause confusion during the initial archaeological investigations of 1962 and 1963, leading to interpretation of these layers as evidence of extensive fire (charcoal and ash) or as layers of lime-rich mortar.[20] More prevalent has been the practice of describing a buried L-H horizon as an old sod or turf-line; this term should be applied only when a turf existed originally, but ground cover locally contains very little grass to produce a true turf except in once-cultivated areas. Hence the term should be confined to sectors where grass had been introduced, such as on the glacis, terrepleins or parapets, and pre-occupation buried surfaces referred to as buried organic layers.

There is little reason to assume any radical change in flora since the 18th century. Pollen analysis from buried surfaces within the King's Bastion reveals a ground cover typical of the coastal plain today: a predominance of heath (Ericaceae) and ferns (Polypodiaceae) with small shrubs (*Viburnum*) and moss (*Sphagnum*). Also present was a tree cover showing a preponderance of species common today, such as balsam fir (*Abies balsamea* [L.] Mill.), alder (*Alnus*) and spruce *(Picea)* with high proportions also of birch *(Betula)*. Pine *(Pinus)* and hemlock *(Tsuga)* were then, as now, not common, but a surprising range of hardwoods no longer found in the immediate vicinity -- such as hickory (*Carya*) and oak *(Quercus)* -- was present, albeit in very small proportions. Maple *(Acer)* and willow *(Salix)* still abound at some distance from the site.[21] Louisbourg was not noted for an abundance of good construction lumber, as St. Ovide and L'Hermitte had pointed out as early as 1713,[22] and the best hardwood stands must have been rapidly exhausted. Significantly, samples of wood surviving in buried surfaces are identified as fir and spruce, while samples of beams and flooring are pine and hemlock. The few traces of hardwood that have been identified are either oak or maple.[23]

Post-Demolition History to 1960

Following the demolition of the fortifications and the eventual abandonment of the town, the site did not, as so often happens in the forest zone of Eastern Canada, revert to its original vegetation. Intensive occupation of a relatively small area (ca. 57 acres) radically changed the soil of the site with the cultivation of gardens and the accumulation of earth fill for the defences. Organic waste and the large amounts of lime used in mortar for the defences and dwellings greatly enriched the otherwise acid soil and a thick turf rapidly developed with the result that the whole area, ruined ramparts and house foundations alike, took on the appearance of open meadowland with low knolls. One species of grass has been identified as being European in origin and is known within the province only in the Louisbourg area,[24] raising the possibility that the French imported grass seed for the purpose of stabilising the ramparts and parapets; however, the grass, while of the strong, tenaciously rooted variety preferred for this purpose,[25] is found around the town but less commonly on the glacis.

While the defences had been systematically demolished and most of the houses destroyed during the siege or subsequently allowed to fall into ruin, the site was not completely deserted.[26] The French were gone, but a British garrison remained in occupation until 1768. By 1784 only four of the old French buildings remained standing and the residual British population was limited to a few families. Throughout the 19th century, settlement was equally limited, settlers of Irish, Scottish or English descent living in shacks along the shore or in wooden houses among the ruins. Animals grazed freely across the site and were penned in those casemates of the King's Bastion that had withstood demolition and the ravages of the climate. Visitors attracted by the romantic allure of history compared the once-thriving town with the desolate heath it had become and sought for ghosts -- or treasure -- in the ruins. On a more practical level, the site became a good source of building material, and many dressed sandstone blocks were removed to Halifax for use in public buildings or taken as foundation stones by settlers occupying the harbour shore outside the fortress. Removal of the entire "east gate," presumably the Maurepas, for this purpose is recorded. Bricks were a valuable commodity too, quarried and sold by lots of a thousand at a time. Where houses were constructed within the limits of the French town, foundations, cellars, wells and latrines left their mark on the site, as did attempts at field clearance and the establishment of property lines. Maps and photographs from the early years of the 20th century clearly indicate the density and type of occupation at the time (Figs. 104, 105). Yet the effect on the archaeological record was mitigated by the size of the site, only the most readily accessible areas being picked over.

Ironically, the worse damage has been the result of sporadic attempts to stabilize or "restore" the ruins. Interest in the site as an historic monument was first expressed at the turn of the century by Captain D.J. Kennelly, Royal Indian Navy (retired), the superintendent and co-owner of the Sydney and Louisbourg Coal and Railway Company, when the company began buying up the old town with a view to extending the railway there and building a coal dock. These plans never materialized and the railway never progressed beyond the northeast end of the harbour, but Kennelly developed an interest in the site and determined to preserve it. He was successful in bringing about legislation declaring the place a national historic monument and establishing a memorial trust in 1903. Over the next three years he concentrated his efforts on the still-standing casemates of the King's Bastion: three on the left flank and four on the right had survived with their stone arches and the rampart above them intact. All loose masonry and protective earth fill over the arches were removed, the intact masonry supported with wooden cribbing and planks, and a cement pad poured on the roofs. Considerable amounts of rampart material must have survived more or less *in situ*, since a 1906 report noted that "about twelve hundred cubic yards" were removed from the roofs and around the casemates, sufficient to build a roadway 700 ft. long and 20 ft. wide across the King's Bastion to the contemporary access road. His activities were confined to structures which had survived above ground, and little excavation below the existing surface was carried out. On the inside of the casemates, a layer of broken stones was deposited on the surface, which was level with the terreplein of the bastion, before the cementing took place. On the left flank the escarp had survived, albeit in poor condition, providing a rear wall to the casemates, and enough excavation was carried out to permit stabilization of the escarp wall down to the level of the casemate floors and the terreplein of the bastion. A drystone drain was installed to allow water in the casemates to run off through the rubble accumulated at the left re-entrant angle.

Kennelly's enthusiasm and energy led to the gradual acquisition by the federal government of all properties within and immediately adjacent to the ruins of the town, and to the eventual declaration, in 1928, of the area as a historic site. Ambitious, if somewhat vague, proposals for the reconstruction of major elements of the fortifications were put forward, along with expressions of concern for the condition of the casemates.[27] Work carried out then was mercifully more modest in scope, although inevitably some of the most interesting areas of the town were objects of attention. In 1930 a museum and caretaker's house were built in what was Block 34 of the French town, thereby destroying house foundations. In the following decade, the casemates were again subjected to maladroit attempts to stabilize them, the façade of the left flank interior was extensively rebuilt, and repointing in cement was carried out on all exposed surfaces. The fill was entirely removed from the two *pavillons* or wings of the barracks and the walls were refaced from the foundation up to terreplein height; the rest of the building was stabilized by extensive repointing, but excavation did not extend much below terreplein level. The ditch on the town side was completely cleared, and the basement wall repointed or rebuilt on its outer surface, and the piers of the bridge across the ditch were reconstructed. Doorways, fireplaces and vents were rebuilt with dubious accuracy, and the bakery ovens in the basement of the north half of the building similarly disturbed. On the townside *place d'armes* the guardhouse foundations were stabilized.

After the war further attempts at stabilization were made under the auspices of the federal Engineering Service. Use of heavy equipment in archaeologically delicate areas ensured that this programme was an unmitigated disaster. The hospital, which occupied an entire town block, suffered the worst damage.[28] The house of the *commissaire-ordonnateur* was similarly treated, and a roadway bulldozed through the ramparts at the site of the Queen's Gate, destroying all traces of the original structure.

Of the work of the 1930s and 1940s, few records remain.[29] Most were apparently destroyed as "dead file" material in the late 1950s, although several photographs of these and earlier periods have survived (Figs. 105-109).

Prior to the present programme, the last major intervention on the site was archaeological testing in various sectors throughout the park in an attempt to determine the feasibility of restoring the surviving remains.[30] The majority of the work consisted of locating the corners of structures and giving a brief description of the condition of the masonry, although the fortifications of the town were not examined apart from the guardhouse at the Queen's Gate and the powder magazine in the Brouillan Bastion. Considering the time and resources available, the programme encompassed a remarkably wide range, even including some test-trenching in the Island and Royal batteries. Unfortunately, there was no subsequent backfilling, with the result that trenches continued to erode and exposed structures to deteriorate. While objects of pottery, glass and metal were recovered, dressed stone doorway and window surrounds of architectural significance were left in the field to be shattered by winter frosts and displaced by work crews.

The various interventions recorded since the fall of Louisbourg all left their mark, but in overall terms, if we except the hospital, the barracks and *commissaire-ordonnateur's* house, the effect on the site was not too serious. In archaeological terms, the town and its defences had been extremely well preserved and offered a rare opportunity for the excavation of a fortress relatively undisturbed since its demise. In 1961 the site appeared as open, grass-covered fields in which the outlines of buildings and streets could be clearly traced; the fortifications were a series of grass-covered mounds and moss-covered rubble in which the demolition craters were clearly visible. Only the casemates and the cemented remains of a few buildings hinted at the extent of the material that lay beneath the surface (Fig. 110).

Restoration Programme and Initial Research

By the same inexorable logic that led Kennelly and subsequent would-be preservationists to the most prominent extant remains, the present programme, officially inaugurated as the Fortress of Louisbourg Restoration Project in 1961, began the reconstruction of the town at the King's Bastion.[1] This accorded with the recommendations of the general consultant, who regarded it as historically apt to begin where the French themselves had begun and proposed that the citadel be reconstructed to resemble its appearance in 1745, as it was then in its most impressive and complete state.[2]

Other arguments also favoured this starting point. By virtue of its importance as the seat of government and its predominant role in two sieges, the citadel was well documented historically, the surviving casemates and stabilized foundations of the barracks made identification and location of other elements of the bastion an easier task than if no structures had existed above ground, and it was felt that the combined effects of siege, demolition and later depredations would have left little else intact.[3] There was, moreover, the pressing practical consideration of providing work for over 200 labourers whose employment had become a political commitment. Under these circumstances, the need for an archaeological programme to provide as much relevant structural data as possible, as quickly as possible, was of the utmost urgency.

Thus began an intensive research programme, closely followed by a reconstruction programme, which lasted several years. Initial evaluations had badly underestimated the complexity of the task in terms of both the initial research and the subsequent detailed design requirements. In this a parallel may be made with the building of the original citadel. The optimism of Verville and enthusiasm of Verrier were soon dissipated by frustrations and delays; begun in 1719, the work was not effectively completed until 1738.[4] Modern construction fared somewhat better, the King's Bastion and barracks being opened in 1969, some six years after the date initially postulated and two years after the whole reconstruction project was to have been completed.[5]

The archaeological work entailed in supporting such a programme was substantial. The numbers of professional staff, the chronology of events and the severe working conditions have been recounted elsewhere;[6] suffice it to say that the rigours of a harsh climate and the difficulties of excavating through unstable rubble and fill adjacent to crumbling masonry, combined with the pressures of an impossible construction schedule, created a formidable challenge to the archaeological team. Excavations began in the summer of 1962 and continued without break until late in 1966. To enable crews to work through the winter months, massive plywood shelters were built over the barracks and right flank areas. Similar shelters on the faces of the bastion and, later, the left flank, permitted construction to be carried out in areas investigated during the summer.

The first season's work was in effect an extension of the general survey undertaken in 1959 and served primarily to locate the remains of the escarp and counterscarp walls and other structural features within the citadel; the complete excavation of such features was nowhere carried out.[7] The season demonstrated the shortcomings of test trenching on a site where total reconstruction was to take place: no one area could be said to have been thoroughly and exhaustively examined, and the risk of destroying undetected features during preparation for construction remained high. Other shortcomings became apparent also. For an archaeologist unfamiliar with the area and with sites of European origin to attempt to unravel the complexities of an 18th-century French fortification in one summer is a formidable undertaking. Not surprisingly, many features were unobserved or incorrectly interpreted and no meaningful stratification was detected.[8] Nor was the amount of historical information available at that time sufficient to support the detailed analysis required for accurate and total reconstruction. A new approach was needed.

It was decided to regard the bastion as a set of architectural components, each one of which could be studied independently and excavated totally before the research findings were released and the sector declared ready for reconstruction. The structurally least-complicated components were given priority in the hope of providing as much straightforward work to construction forces as possible, thereby allowing researchers the time to continue on the more controversial sectors free of interruption. Thus the first components examined and then reconstructed were the relatively featureless escarp walls of the faces.

Such a research model[9] was not without its drawbacks, the two most serious being the nature of the historical evidence and the subsequent integration of all pertinent information. The architectural and archaeological units into which the bastion could be readily divided were not necessarily reflected in the documentation, which was essentially a record of work progress within a certain period (usually a year) or of work proposed for the following year although specifications to contractors provided valuable details on materials and methods.[10] That the bastion lent itself to dissection into discrete components for study purposes should not obscure the fact that it was designed and built as a whole. While all available information for the faces might have been analyzed and synthesized, evidence essential for determining the height of the ramparts might only be available from the examination of the flanks still in progress. Similarly, the slope of the parapet and angles of fire might only be deduced from the examination of related features outside the bastion itself, since a fortification front was from the flanked angle of one bastion to the flanked angle of the next. Ideally, the integration of all the evidence, fully assessed and evaluated as a whole, should precede any attempt at reconstruction, but circumstances did not allow sufficient time to carry this out as fully as was desirable.

Architectural Components

The identification of the various architectural components and the nomenclature adopted were based on standard fortification terminology to which specific historical data were added. Thus the bastion, which by all historical indications was nearly symmetrical, could readily be subdivided into a right face and right flank, left face and left flank. In keeping with standard practice and the practice of the builders of the King's Bastion, left and right were in relation to an observer within the fortification looking out towards the country.

The flanks and faces together comprised the ramparts, which could be further subdivided into masonry escarp, earthen rampart fill and, in this case, masonry interior revetment. Technically, the ramparts were considered as stopping at the cordon level -- the magistral line on which all plans were based and to which all lengths referred. The horizontal surface at this level was the terreplein of the rampart, above which rose the parapet. Within the ramparts of the left and right flanks were casemates; additional ones occupied part of the right face ramparts.

The delimitation of the ramparts by a masonry interior revetment created a large, well-protected area below rampart level. The bastion was designed to be hollow, the level space enclosed by the ramparts being referred to as the terreplein of the bastion. Use of interior earth slopes to terminate the ramparts, as used elsewhere at Louisbourg, would have considerably reduced the size of the terreplein and restricted troop movements in this strategic strong point and access to the casemates would have been more cumbersome also.

The gorge of the bastion was closed by a long masonry building which effectively controlled all access to the interior by means of a central passageway which conveniently divided the building into north and south halves. For a long time the whole structure was referred to as the Château St. Louis, but recent research[11] was demonstrated that there is no historical basis for this appellation, seemingly first introduced by McLennan.[12] The primary function of the building was as a barracks and the main section of the north half was reserved for this purpose; officers' quarters took up a substantial portion of the south half. At each extremity was a wing or *pavillon*, the one to the south serving as the governor's residence and official headquarters, and the one to the north as the quarters of the *commissaire-ordonnateur*, although the various officials succeeding to this post never did reside there. The garrison (later the entire town's) chapel was located in the south half.

The barracks was cut off from the town by a ditch which could only be crossed by a bridge, the last section of which was raised or lowered from the guardroom adjacent to the central passageway. The ditch was defended by a covered way and glacis facing the town. A sally-port or postern tunnel from the covered way to the main ditch of the bastion was located at the junction of the right flank and the curtain wall. Opposite the central passage through the barracks, the covered way was expanded to form a *place d'armes* protecting the entrance in the manner of a medieval barbican or a simplified *demi-lune*. The incorporation of this work into the covered way and glacis preclude its being a true *demi-lune*, but in other respects its form and functions were very similar. Approaching from the town, all persons wishing to enter the barracks or bastion first passed through the glacis by way of a restricted, curved passageway, crossed the *place d'armes*, and came to the guardhouse located directly in front of the bridge over the ditch.

The bastion was thus defended from the country by its ramparts, and from the town by the retrenchment comprising the barracks, ditch, counterscarp and glacis, thereby justifying its description as a citadel. Most commonly referred to as "Le Bastion du Roy," the whole unit, including the barracks and townside defences, was from the beginning intended to be the principal element of the defences: the "grand bastion" or "bastion du roy servant de citadelle" of the earliest plans.[13] The concept of an isolated "redoute" or "redoute bastionnée" was modified sufficiently to favour early adoption of the simpler term "bastion" by those authorizing the project.[14] It was nevertheless an independent structure until the curtain walls on either side were started in the late 1720s. The citadel had been a major preoccupation of the French; it had withstood two sieges and undergone considerable modifications before its demolition. The seat of colonial government and barracks for the garrison, it was the scene of intensive occupation in peace and in war. The actual physical reconstruction was to be as faithful as possible to conditions in 1744/45 and it was the archaeologists' task to distinguish between the various periods of occupation.

Construction Concepts

Verville proposed "a strong bastioned redoubt, built out of masonry, with two faces each 35 *toises* long, and two flanks each 10 *toises* long, the lines of defence being drawn from the extremities of the curtain walls."[15] (Author's translation.)

The preparations he envisaged showed exemplary care for detail and precision.[16] So, too, did his instructions to his assistant engineers de Couagne and de Fontenay the following year once the council had authorized the project. In every respect, the approach to the work recalls the 17th- and 18th-century publications on fortification or the unpublished memoirs of such engineers as Masse.[17] Verville's preparations began with his instructions for clearing the ground and staking all interior and exterior angles of the fortifications. Excavation for the foundations was to begin 3 *pieds* behind the line the cordon would follow, and proceed down in a series of steps (banquettes) until solid rock was encountered.[18] (This technique is explained in *La Science des ingénieurs*.[19]) Earth and rubble-stone from the excavation was to be stockpiled in long lines parallel to the faces so as to be convenient for construction, but also to serve as a defensive fieldwork in the event of a surprise attack.[20]

The neatly ordered textbook approach had to be modified in the following years. The revised instructions for 1718 specified a bastion with faces of 40 *toises* long and flanks of 20 *toises*; the flanked angle was to be 125 degrees and the shoulder angles 115 degrees each and the barracks across the gorge was to be 57 *toises* long. For the first time, the idea of bombproof shelters *(souterrains)* was proposed; two, parallel to the escarps and buried in the rampart fill, were specified for each flank.

The whole work being located on a hill, it was clear, as Verville had already noted, that the amount of earth to be moved would vary from one section to another. At the flanked angle, near the highest point of the hill, the cordon would be practically at ground level, whereas on the right flank, the rampart would have to be built up some 20 *pieds* to reach the cordon. Because the amount of excavation necessary for the foundations was least on the right flank, work was to begin there. Furthermore, raising the part of the fortifications that could command the front as far as the harbour shore was considered a prudent defensive measure.[21]

While the preliminary work was to be carried out by soldiers directly under Verville's orders, it was decided that construction would be entrusted to an independent contractor from France.[22] The practice of building the king's works by contract was a time-honoured tradition under the Ancien Régime, and one generally held to be more efficient and economical.[23] The role of the engineer was to prepare detailed plans and specifications for the contractor and to ensure that the work was carried out in strict accordance with these instructions. Additional technical advice and certain specialized services, such as blasting rock, were to be provided should the occasion arise. One of the engineer's most important functions was preparing detailed accounts recording the progress of work and serving as the basis for payments to the contractor. The quantities of earth removed during excavation, the amount of stone used in the construction of masonry walls and all other building materials were carefully recorded in the *toisés* as stipulated by very explicit memoirs to all military engineers.[24] The extent to which the Crown received good value for money was a direct reflection on the competence and conscientiousness of the engineer; by the same token, the just and prompt compensation of the contractor rested in large measure in his hands.

Considering the completeness and concern for detail that was the hallmark of the French military engineers, it is ironic that of the quantity of *devis* that must have been prepared for Isabeau, the contractor, none have so far been located. We are left with the *toisés* prepared by Verrier, after he had replaced Verville, as a means of estimating the work done and of determining payment,[25] together with the plans of progress and work proposed (Figs. 111, 113-119).

While visually very informative, the plans are of limited use in providing accurate dimensions since the scale is too small to work from, to say nothing of the errors caused by distortion of the original and later copying. (There was never a true, unique "original" but several, all drawn at the same time [and usually signed by the engineer] to be sent to different government agencies; thus identical plans may be located in various archives.) The *toisés* have limitations of a different sort: they were a means of estimating work done and hence recourse was frequently made to the averaging of quantities in order to arrive at a fair total. In calculating the amount of masonry used in a wall, for instance, irregularities in the depth of the foundation do not appear as such: a uniform average height is assumed for the entire length in order to calculate the total volume. In some instances, calculations from several separate units are combined to produce a total, with the result that detailed dimensions are obscured or precise work areas impossible to locate.

On the other hand, it is difficult to argue with the reliability of the evidence contained in the *toisés*. They represent formal confirmation by the engineer that everything was built as recorded, and he was placing his career and his competence in jeopardy if he approved work he had not scrupulously checked.

Escarps

The first question was whether the surviving remains represented the bastion as originally built, or whether siege damage and subsequent repair had been so extensive that an essentially post-1749 structure was all that remained. The various components of the bastion revealed different answers. In the case of the right face and left face escarps, little had survived above the footings. Some sections of the right face were as high as 2.5 m, but for the most part only two or three courses of rubble-stone masonry could be identified and in some sections, particularly on high points on the bedrock, no masonry at all remained. The left face had suffered even more: masonry was entirely absent in several sections, and nowhere was the wall intact above 1.52 m. So dilapidated was the exterior facing that its alignment was initially calculated from a section that had become detached entirely from the foundations; the subsequent spilling-out of rampart fill obscured the underlying courses and led to the erroneous assumption that undisturbed soil had been reached.[26] The amount of loose rubble and unstable fill made extensive excavation by hand both impractical and dangerous; frequent cave-ins were experienced. Once sections across the rampart had been established, the bulk of the loose material was removed by machine and a more complete picture of the escarps emerged. From the left shoulder angle to the flanked angle, bedrock undulated slightly from a high of 11.06 m above sea level to a low of 8.68 m. The foundation was situated directly on bedrock for the greater part of its length of 78.04 m, but in some instances the hard-packed glacial till had not been removed, being firm enough to support the walls.

The right face escarp presented a similar appearance, although sections of wall had survived for several courses higher than on the left face. Bedrock, however, sloped away more sharply. From the flanked angle to a point less than midway along the escarp was a drop in elevation from a plateau of 10.3 m to 8.6 m; from there to the shoulder, after a short level section, the bedrock dropped to 5.6 m. Once the plateau at the flanked angle, has been passed, no attempt was made to locate the foundations on bedrock. Of a total length of 78.63 m, some 50 m of wall were founded on glacial till varying in depth from 0.5 m to 3 m. At its highest point the wall was intact to a height of 2.45 m; elsewhere, average surviving height was 1.3 m, with a gap some 2.5 m wide midway along the wall where no masonry was present.

The area of the right shoulder angle was utterly ruined, the only surviving traces being some dressed sandstone quoins and of these, no stones confirming to the actual angle of intersection between face and flank were found. It was here that conclusive evidence as to the date of the surviving sections of escarp was discovered: a lead-covered wooden block into which three medals commemorating the foundation of Louisbourg had been set. "On a mis la première pierre le 29 May 1720 avec les ceremonies accoutumées" reported Mézy.[27] Because the right flank had been given priority, the base of the shoulder angle was laid before that of the flanked angle, which otherwise might have been a more appropriate location for such a ceremony.

In the absence of any indication of modifications to the foundations or of refacing the wall immediately above, it was deduced that the escarps of the faces had retained their original characteristics through two sieges. Their final appearance can be attributed to the effects of the second siege and particularly to the systematic demolition carried out two years later. Plans of this operation[28] leave little doubt as to the cause of the gaps in the masonry and the almost total disappearance of the right shoulder (Fig. 102).

Evidence from the excavation of the flank escarps revealed a somewhat different sequence, and, on both flanks, parts of the walls had survived to a considerably greater height. The reasons for these differences were not entirely the same in both cases.

In the area of the left flank, bedrock was fairly high, although gradually sloping from 9.82 m above sea level at the shoulder angle to 8.22 m at the re-entrant angle. Somewhat surprisingly, the foundation of the wall was in places located on the hard, compact till which filled in the hollows to a depth of between 0.5 m and 1.0 m. Demolition in the immediate vicinity of the shoulder was almost total: the breach was 6.5 m wide and only two courses of dressed sandstone quoins forming the angle survived (Fig. 135). Other masonry was intact and near the re-entrant angle the escarp was all of 5.7 m high (Fig. 136). The primary reason why the wall had withstood siege and demolition to such an extent was the support and reinforcement provided by the casemates built into the rampart against the rear of the escarp (Fig. 137). Only at the shoulder angle, where the earth fill of the left face rampart adjoined the flank, was a weak point where demolition mines buried deep in the fill exerted their maximum force and caused the most widespread destruction.

The left flank had not been a principal target in the two sieges and therefore emerged relatively unscathed. Its vulnerability and overall condition were nevertheless a matter of concern to Franquet, who, in preparation for the second siege, raised a "Chemise en gazons, et en saucissons" in front of the walls.[29] In another memoir the engineer was more specific. He was initially concerned with the dilapidated condition of the left face and felt that repairs were urgently needed; short of totally rebuilding it, a makeshift earth and turf revetment against the exterior would have to suffice.[30] He considered it prudent to cover the right face and the left flank as well, but as no more turf *(gazon)* was available, the job was finished with fascines. The large quantities of distinctively stratified earth against the left flank near the re-entrant angle are thus explained (Fig. 138).

The original rubble-stone wall, founded on bedrock or hard-packed glacial till, had survived intact to a height of almost 6 m. Set in this wall was a drain opening of dressed sandstone (Fig. 136) which had originally served as a means of evacuating water from inside the bastion through a casemate and into the ditch, but when found, the opening had been solidly blocked with rubble and mortar. Clearly, the covering of earth and fascines would render the drain useless, but would not necessitate such a thorough blocking. If we assume that the drain was functioning immediately prior to the makeshift work, we may also assume that the drain opening was regarded as a weak point in the escarp and was filled solidly with masonry in an attempt to stabilize a wall feared to be unsound.

Other events attested to archaeologically can be attributed to Kennelly's activities at the beginning of the century. The exterior of the upper section of the escarp adjoining the surviving casemates had been heavily repointed in cement to a depth of between 1 and 2 m. In one area, the work had gone deeper: an irregular intrusion in the fascines fill corresponded to a V-shaped dip in the repointed masonry which reached down to within 0.5 m of the drain. Extending out from the escarp at the bottom of the instrusion was a rubble-stone drain which had been capped with flat stones before backfilling (Fig. 138). The restorers had obviously been looking for the original drain, guided by the existence of a drainage channel on the inside of the casemate nearest the re-entrant angle; equally obvious is the fact that they did not find it. Presumably the blocking of the drain which could be seen at the rear of the casemate persuaded them that the drain no longer existed on the exterior, and, having descended to what they calculated was a sufficient depth to reveal any such feature had it survived, they abandoned the attempt. Construction of the rubble-stone drain was their attempt to channel away water seeping through the wall once it had followed the course of the surviving drainage channel to the rear of the casemate.

The sequence of events uncovered on the right flank escarp was more relevant to the history of the bastion. The right shoulder angle, like its counterpart on the left, had been effectively demolished, leaving little trace of either face or flank escarp in the immediate vicinity. For some 4.5 m from the shoulder nothing had survived and for 10.6 m the wall was barely 1 m high. The remaining section to the re-entrant angle, some 23 m long, survived to a height of between 4.9 m and 5.2 m, although the outer facing had not always remained to this height (Fig. 139).

The right flank differed considerably from the other escarps. The most noticeable feature was the presence of upright timber beams set at regular intervals of 1.9 m centre to centre in recesses in the masonry. Furthermore, the masonry itself was different: where metamorphosed rocks had been used, many had been roughly squared to permit the masons to use tighter, more uniform joints. In addition, dressed sandstone blocks in considerable numbers had been built into the wall, most strikingly as a sill course at or slightly above ditch level. Where the upright timbers joined this sill, the underlying stones had been cut to receive the beams. Closer examination revealed that horizontal as well as vertical timbers had been built into the wall. (The terms "vertical" and "horizontal" are not strictly correct: the uprights were parallel to the face of the wall, which was inclined to a batter of one in eight; the beams built into the thickness of the wall were perpendicular to the exterior face.) Three stages of horizontal beams were found, each securely attached to an upright by a mortise-and-tenon joint and further secured by a wrought-iron spike. Spaced as they were at vertical intervals of 2 m, there would have been room for another two stages before the top of the wall -- at cordon level -- was reached. The timbers were substantial, averaging 17.8 cm wide and 15.2 cm thick, and may have contributed to the strength and resilience of the wall. However, wrought-iron spikes with large heads, protruding some 5.7 cm from the uprights, together with traces of wood aligned horizontally, indicated that reinforcing the masonry was not the purpose of this construction technique; the uprights were intended as nailers to which heavy planks were nailed.

Documentary evidence established precise dating of the repair work and threw further light on construction methods in Louisbourg. The right flank, exposed as it was to fire from the hills in front of the Dauphin Half-Bastion and across the harbour, had been badly damaged in the first siege, as both English[31] and French sources attested. The French engineer Boucher reported that:

> The right flank of the bastion is one of the sectors which was most badly damaged by the besiegers' artillery fire, the top of the exterior revetment being demolished to a depth of four *pieds* along the entire length [although] the damage decreases towards the

> foundation, at which point none is discernible.[32] (Author's translation.)

He noted that the English had done little permanent repair, contenting themselves with a massive timber platform set on the ruins of the terreplein of the rampart to serve as a gun battery. He recommended rebuilding the wall and drew up estimates for using pine beams and planking there and elsewhere on the defences.[33]

Boucher's remedy was not innovative. The technique had previously been employed elsewhere at Louisbourg, but it was not judged to be an ideal solution and ministerial approval was reluctant.[34] Franquet, by now familiar with the local situation, gave a somewhat rambling and pessimistic reply to the minister, justifying the need for a plank revetment as the only way of stopping stones falling out of the wall while the mortar set.[35] The right flank was the only escarp so treated, and then not until 1755.[36]

It was the remains of this rebuilt wall that the archaeological investigations had exposed, standing buried in rubble much as it had been left following the second siege and subsequent demolition. As far as could be determined, the escarp had been rebuilt with a batter of one in eight on its outer face, differing from the original wall's specification of one in six. Largely obscured by the crumbling masonry at the re-entrant angle were several courses of dressed stone, while beneath the horizontal sill-course on which the timber uprights were set, an irregular base of rubble-stone was apparent. Consideration of these factors held out the possibility that contained within or behind the repaired escarp was further information relating to the original. The systematic dismantling of the surviving masonry was therefore decided upon.

Any hopes that traces of the original face of the wall remained behind the repairs were soon disappointed. Once the outer stones had been removed, an undifferentiated mass of rubble and mortar extending back some 2 m was encountered. This is understandable in terms of wall construction observed throughout Louisbourg: the exterior face of the wall consists of stones laid in more or less regular courses, some attention having being paid to the joints and bonding. The interior face was similarly treated, but little attention was paid to bonding throughout the entire thickness of the wall, the core of the wall consisting of randomly deposited stones and rubble smothered in mortar. A masonry sandwich is thus formed, with reasonable bonding on the surfaces only. This is just the situation that Belidor warned against:

> When all these precautions [complete bonding throughout the wall] are not taken, the exterior revetment, not being well bonded to the rest of the escarp is strictly speaking one wall resting against another, which, as it begins to deteriorate, separates away in a short time, the whole outer wall falls, and only a shapeless mass which is extremely difficult to repair soundly is left....[37] (Author's translation.)

Under such circumstances the strength of a wall depended largely on the consolidated mortar and rubble core. If the mortar did not set properly or was exposed to the elements, once the outer surface had scaled away, the rest of the wall would crumble. In the case of the right flank, the disintegration of the outer surface, resulting in the condition Boucher described, was due to enemy artillery, but as Franquet made clear, it was a general problem with all the masonry.

Thus much of the crumbling core of the right flank escarp had to be removed prior to major repair. A satisfactory bond between old and new had been achieved, but it was possible to distinguish between the two (Fig. 140) and see that the base of the original wall had been used as a foundation for the new. Unlike the escarps of the faces and left flank, it appeared that the right flank escarp was seated on a specially prepared base and an examination of bedrock made clear why this was so. At the right shoulder angle, bedrock was 5.36 m above sea level, but after rising slightly, it fell away again to form a hollow no more than 5 m above sea level for a distance of 14 m, roughly one third of the entire length of the escarp. Bedrock rose to its highest point just in front of the sill of the postern tunnel (6.94 m) and rose slightly again behind the line of fortifications. The natural lie of the ground meant that the least amount of excavation in preparing the foundations was required in the right flank area, providing a convenient starting point for construction. Not only was the ground low-lying here, it was swampy and required drainage; early plans indicate attempts to channel water away from the flank and downhill to the pond between the King's and Dauphin bastions,[38] and a rubble-stone drain was found running through the base of the escarp from the bottom of the third casemate of the flank. This drain, clearly marked in the elevation of the flank shown on the 1720 plan (Fig. 113), served as a run-off for excess water from the well inside the bastion.

Given such conditions, it is not surprising that the builders felt it necessary to provide a more substantial base to the ramparts in this area than elsewhere, and large amounts of rubble and mortar fill had been deposited in the hollow. The foundation thus followed the original contours, but was rarely located directly on bedrock; in the hollow, it was approximately 1.2 m above it.

Thus far the archaeological sequence appeared to be a straightforward one of construction, damage, repair, further damage and final abandonment, but evidence from the area of the re-entrant angle and from analysis of dressed stones recovered from the rebuilt escarp indicate a more complex sequence. Behind the unstable rubble between the postern entrance and the intersection of the curtain wall and right flank escarp was a column of dressed sandstones (Figs. 141, 142) set on the rubble masonry foundation belonging to the original escarp; its location in this context demonstrated that the original wall was in fact 3.2 m wide at the base as opposed to 2.9 m, and built to a batter of one in six, not one in eight. Given the initial concept of the bastion as a free-standing redoubt, it is logical to make a direct correlation between these stones and the quoins shown in elevation on the 1720 plan (Fig. 113); however, except for one stone, quoins conforming to the angle itself were not found *in situ*. Stones placed at the corner, with one face cut to match the batter of the escarp, the other to match that of the termination wall of the flank, should have been found, but the masonry had been cut back, presumably to incorporate the curtain wall from one direction and the postern tunnel from another. The cornerstones themselves had been removed and only a few of the adjacent stones, cut to the slope of the escarp, had been left.

Built into the repaired escarp, either as stones recut to accept timber uprights or simply as conveniently squared blocks useful for good coursing and bonding, were some 200 dressed sandstones displaying worked surfaces which had belonged to previous structural features. Presumably these had fallen from the ruins of the original right flank and were readily available for reuse in the rebuilding programme of 1755. No less than 17 of these stones were quoins cut with a batter of one in 12 on one face and one in six on the other (Fig. 143), all clearly quoins from the end of the flank. Documentary evidence, however, fixes the date of construction of the postern tunnel to 1736,[39] while the repairs incorporating the quoins took place nearly 20 years later.

A crater in the rampart of the curtain near the re-entrant angle, together with the ruined state of the postern tunnel in the section passing through the curtain escarp, suggested that the demolition team had profited from the existence of the postern to place a mine in the rampart of the curtain behind the escarp. Remnants of a timber-shored opening, by which the sappers would have broken through the wall of the postern and into the rampart, lend weight to this supposition. As the escarp of the curtain was in poor condition, it was decided to enlarge on the demolition damage to establish a cross-section of the curtain. A sequence of repair on an original base, similar to that on the right flank, was observed. The sill stones of the postern proved to have been reworked: originally they had been cut for a different location (Fig. 146). One was identical to stones reliably identified as window sills from the barracks, while two others were cut to a batter of one in three, the same slope as the basement walls of the barracks wings.

Archaeological evidence thus indicated that not only the right flank, but also the re-entrant angle and postern entrance had sustained severe damage and had required major repairs. Under such circumstances, any quoins from the terminating wall of the flank which had been left *in situ* above the postern tunnel could well have been dislodged at the time the damage occurred, and were then at hand when the repairs were undertaken.

Imposing as they were in their own right, the escarps were elements of a larger unit -- the ramparts -- and as such their primary function was a passive, retaining one.

Ramparts and Casemates

Ramparts universally served a number of discrete functions. In an attack they provided the main obstacle to a direct assault and prior to an assault they offered shelter against the inevitable artillery bombardment to defenders immediately behind them and, to a certain extent, to the town and its inhabitants enclosed within the walls. From the point of view of maintaining an active defence, the ramparts were crucial, providing a firing position with sufficient command of the country in front of the walls to discourage an enemy advance. The ramparts of the King's Bastion were designed, as were its European contemporaries, to respond to these requirements in two ways. In terms of active defence, the role of artillery was conceived of as primarily to provide flanking fire and hence would be concentrated on the flanks; musketry fire would be concentrated on the faces, firing on the covered way and glacis over a parapet. In terms of shelter, the faces were to depend mainly on the thickness of earth fill to withstand enemy artillery, while vaulted bombproofs were to provide better cover in the flanks. The outer edge of the ramparts was delimited by the escarp, a masonry revetment 10 *pieds* (3.25 m) thick at the base and built with a slope or batter of one in six on the outer surface; the inner edge was likewise delimited by a masonry revetment although it was considerably less substantial. On the left and right faces, the interior revetment was 1.0 m thick and vertical. Between the rear of this wall and the rear of the escarp -- a distance of 12.2 m -- the rampart of the left face consisted simply of earth fill. The unstable nature of the dense, stony material, derived primarily from the C horizon of the glacial till, together with the undulating bedrock close to the surface, made evident the problems the French encountered in digging out the foundation trenches and consolidating the rampart fill. It was likewise clear why Verville's model excavation descending in neat terraces had had to be abandoned.

The rampart of the right face presented a slightly different picture. Near the flanked angle, fill was encountered throughout, as on the left face, but 37.5 m from the junction with the right flank were found the masonry foundations of eight rectangular cells built into the rampart (Fig. 147). Smaller than the casemates on the flanks and not extending the full width of the rampart, these casemates had nevertheless been intended for the same purposes although the archaeological evidence indicated an early change of plan.

As a means of identifying each unit readily, the casemates were assigned numbers in sequence, starting with 1 nearest the barracks; those to the left of the capital line received the suffix L, those to the right, the suffix R. Of the casemates located in the right face, designated 8-15R, casemates 13, 14 and 15 appear never to have been completed, since the interior revetment of the rampart was built without interruption across the ends of all three, sealing off any access to the bastion terreplein. Nor was there any trace of roofing material, and they were entirely covered by packed glacial till forming the mass of the rampart. Casemates 10, 11 and 12 all exhibited more signs of use, 11 and 12 each having a doorway which had been subsequently blocked. Rubble masonry inside 10 to 12R, overlain by rampart fill, suggested the partial demolition of walls prior to the raising of the rampart.

Only the two casemates nearest the right flank (8 and 9) showed any sign of completion and prolonged use. In both were found quantities of collapsed masonry in which flat fieldstones predominated, indicating the presence of vaulted roofs at one time. The separation walls between casemates 9 and 10 on the one side and casemate 8 on the other survived to a greater height than those in the other casemates, lending weight to the theory that these casemates had been built to their full height and roofed. Casemate 9 was provided with an entrance, the surround being constructed of flat fieldstones with a rebate allowing for a door opening outwards; the sill consisted of two sandstone blocks, cut with a rebate to match the upright surrounds, and anchored together with a wrought-iron crampon. No entranceway to casemate 8 was found since the interior revetment, closing the front of the casemate, was in this area demolished almost to terreplein level, possibly as a result of salvage expeditions looking for building materials subsequent to the abandonment of the place. However, the existence of a cobbled floor inside the casemate and a drainage channel of worked sandstone blocks running from the interior revetment wall to the rear of the casemate (Fig. 148) suggested that an entranceway, similar in dimensions to that of casemate 9, would have been built into the interior revetment.

Unlike the other casemates, casemate 8R was not rectangular in plan. Its shape was determined by the intersection of the right face and flank ramparts, for in effect an extension of the interior revetment of the right flank served as its northwest wall while the interior revetment of the face served as its east wall. Another feature setting casemate 8 apart from the others is an opening in the rear, northwest wall that provided access to casemate 7R, a small, rectangular chamber deep in the rampart behind the right shoulder. The wall between the two was badly damaged and no trace of an entrance was found, but the drain in the cobble-stone floor of casemate 8 passed through the remains of the separation walls. The existence of a doorway with the drain running under its sill, or a simple opening with the drain in the centre, must therefore be presumed.

The casemates of the right face represent an early construction concept which was modified by the time the interior revetment was completed and the rampart brought to its full height. All but the two closest to the junction with the flank were unfinished and filled in. Their abandonment appears to have been due in large part to the rivalry between Verville and the local administration.

> [Verville] has built 6 or 7 small casemates in the right face of the bastion although these are definitely not included in his construction proposals from what we gather, because he certainly has not informed us.... (author's translation)

complained St. Ovide and Mézy to the council.[40] They also protested that the right flank casemates were being given priority over the barracks despite problems of accommodation.[41] The upshot was a reassigning of priorities and, eventually, Verville's replacement by Verrier. The latter's first plan drawn at Louisbourg, showing the partially completed King's Bastion in 1725 (Fig. 115), still indicates the right face casemates as consisting for the most part of walls a little higher than the terreplein and having no roofs; however, casemates 8 and 9 are depicted as finished. In addition, some form of cover overlying casemates 11 and 12 is also shown, matching the description of a temporary powder magazine with a plank and shingle roof spanning two casemates erected by Verville in this area.[42] Still apparently in use as late as 1730,[43] the magazine must have been demolished shortly thereafter when work was resumed on the rampart and the interior revetment completed.[44]

With the exception of two structures behind the shoulder angles, the casemates of the flanks were considerably larger than those of the face. Because of the sharp slope of the hillside, the right flank casemates were naturally well below the surface of the bastion terreplein and were thus true "souterrains." No attempt was made to achieve any uniformity of depth; the contours of the terrain were followed with little effort expended to modify the ground. Indeed, in several instances traces of original land surface, complete with tree roots and stumps, were observed.[45] Thus the depth of the casemates was determined by natural features rather than structural considerations, and a direct relationship with the base elevation of the escarps therefore existed. At the right re-entrant angle, where bedrock sloped upwards to the south and east, casemates 1 and 2R had foundations at an average elevation of 7.2 m above sea level, or 3.3 m below terreplein level. Casemates 3, 4, 5 and 6R were located in the hollow in the centre of the right flank and had foundations 4.1 m below the terreplein.

In other respects the six full casemates of the right flank were structurally similar. The rear of the escarp served as their common end wall to the northwest, while to the southeast the interior revetment of the rampart fulfilled the same function, except that doorways set in this wall provided access to each casemate. There were no intercommunicating doorways, each casemate being entered only from the terreplein of the bastion. Each was 10.36 m long. Separating them were massive partition walls of rubble masonry 1.46 m thick, bonded to the interior revetment and to the rear of the escarp, and supporting vaults of flat sandstone slabs which in turn supported the terreplein of the rampart and parapet above (Figs. 113, 114, 128, 129). Some measure of the strength and solidity of the construction can be gauged from the fact that four casemates (1-4R) had survived the devastation of sieges and demolition with their vaulted roofs intact. Unfortunately, many details were lost in the attempts at stabilization carried out earlier this century when all loose materials were scraped away from the terreplein of the rampart and cement poured over the tops of the arches. The undersides of the vaults were similarly treated, the mortar being held in place until it dried by plank revetting (Fig. 105). The interior revetment was virtually rebuilt down to terreplein level and all trace of the original doorways obliterated. From an area that had received considerably more damage came, paradoxically, enough evidence to form a complete picture of the original entrances. The almost total collapse of the rampart at the right shoulder angle had obscured the entrances to casemates 5 and 6 under masses of rubble. Preserved, albeit in extremely deteriorated condition, were enough sandstone sill and jamb stones to justify the conclusion that the entire door surround had been of worked sandstone blocks. A surviving wrought-iron pintle, still embedded in the jamb, indicated the manner of hinging the door and the direction in which it opened. On the terreplein in front of casemate 5, several dressed sandstones were located and when re-assembled, a virtually intact doorway surround emerged, complete with adjoining vents (Fig. 149). It was postulated that the remaining casemate entrances were similarly finished.

Unlike the six units whose lengths were effectively the same as the full width of the rampart, casemate 7R was smaller (4.57 m x 3.66 m). Rampart fill of the right flank and face lay behind its northwest and southwest walls, and the only access to it was via casemate 8R. The most interesting structural feature discovered in 7R located in the casemate's northwest or rear wall. Remains of a drain, in many respects similar to that found on the left flank, ran through the wall and into the fill beyond, presumably to emerge eventually through the escarp, although the extent of destruction in the shoulder area precluded any possibility of tracing it further. Within the wall the drain channel consisted of a carefully worked sandstone base flanked by coursed rubble-stone for the sides and arch (Fig. 150). The channel originally must have completely spanned the casemate to join the drain crossing the floor of casemate 8.

The bastion being essentially symmetrical in plan, it is not surprising that the disposition of the left flank casemates bore many similarities to that of the right: six full casemates, one small one behind the shoulder angle, and the same arrangement of partition walls and vaults. In the absence of any casemates on the left face, a special passageway, with a doorway let into the left face interior revetment, curved into the shoulder angle to provide access to the small casemate 7L. Three of the larger units (1-3L) had survived with their vaults intact and hence had also been subjected to 20th-century attempts at stabilization which obscured structural details. However, excavation of the remaining three casemates yielded information on the differences of detail between the casemates of the two flanks. Immediately apparent was the much shallower depth occasioned by the lie of the land. The original hillside had been quite high in this area, with a gradual rise from the re-entrant angle to the shoulder. Casemate 1 was thus the lowest, the foundations of its walls set on compact glacial till. The hillside also sloped up from the ditch towards the interior of the bastion, with the result that the casemates sloped down from their entrances in the interior revetment to their end walls formed by the rear of the escarp (Fig. 125). Maximum height was some 4 m at the most. A simple earth floor was common to all.

The junction of the left face and flank had survived somewhat better than its counterpart on the right. The entrance to casemate 6L, although lacking its lintel, was largely intact; so too were the vents on either side (Fig. 151). The design was similar to the doorways of the right flank casemates, but the material was not; flat sandstone slabs, used very much as a mason would lay bricks, surrounded the openings. On the basis of more fragmentary evidence from the badly damaged casemates 4 and 5L, together with the less reliable information from the three entranceways restored by Kennelly (Fig. 106), it was possible to conclude that the entrance and vents to casemate 6 were representative of all such openings on the left flank.

Both vents had been blocked with rubble masonry. In the case of the one nearest the left face, the reason was self-evident: the interior revetment of the face had been constructed to intersect the flank just beyond the doorway of casemate 6, obscuring the vent entirely (Fig. 151). A similar situation must have also occurred on the right flank. The flanks had been built before the interior revetments of the face were laid out, as Verville's construction schedule has shown, and the overlapping of the later revetments clearly attest to a modification of plan, since there would be little sense incorporating features in a structure only to block them in the next phase of building. The change nevertheless must have been decided upon at an early stage. Boucher's 1720 plan of the town indicates the progress of construction within the bastion and shows the foundations of the right face casemates, and hence the junction with the flank, as already laid (Fig. 72). An unsigned plan of the bastion dated to the same year reveals the same sequence of progress and indicates considerable overlap between the interior revetments of both faces and flanks (Fig. 113). A 1724 plan detailing the bastion leaves no doubt on the matter, since the vents and doorways of all casemates are clearly indicated (Fig. 114). What had happened? The degree of overlap is roughly equivalent to the thickness of the interior revetment (3 *pieds* or 0.98 m). Possibly the alignment of the faces had originally been laid out without taking this into account, although such an explanation scarcely seems plausible in the case of qualified military engineers. Alternatively, the rampart of the faces might have been judged not wide enough, especially with the inclusion of a barbette at the flanked angle, and modified accordingly. There is, somewhat surprisingly, no mention of any such change in any of the documents nor comment on the blocked vents in later inspection reports. The question remains unresolved.

The presence of drainage channels in casemates 7 and 8R has already been mentioned, as well as the discovery of an opening for a drain, subsequently blocked, on the left flank. The drain leading to the opening in the escarp had been discovered by Kennelly in casemate 1L and the channel, cut into a series of sandstone blocks laid in the earth floor, had been left in place (Fig. 121). Two further issues are raised by these features: the use to which the casemates were put, and the overall drainage pattern for the bastion.

Evidence as to the former is scant. The casemates, both in the original proposals and as modified, were designed with no openings through the escarp for artillery and hence did not constitute an active part of the defence. Casemates were originally designed as retired flank batteries covering the ditch in front of the curtains, and although military engineers of the latter half of the 17th century had favoured simpler, solid flanks for bastions, a reversion to casemated artillery was already indicated in Vauban's tower bastions, especially at Neuf Brisach, and became a predominant theme of later 18th-century military architecture. At Louisbourg, however, the features were incorporated strictly as a means of providing bomb-proof shelter in time of siege. The terminology does not appear to have been consistent, "souterrains," "cazemattes" and "flancs cazemattez" being used interchangeably. To the British, they were "casemates" or, more simply, "bomb-proofs." The primary function of all the casemates was thus denoted. Less apparent, perhaps, but ultimately more significant was their structural role as an integral part of the ramparts. The massive separation walls between casemates extended the full height and width of the ramparts of the flanks, providing more efficient and solid buttressing than could be achieved even by adding counterforts behind the escarp, the casemate arches tied the entire rampart together, and the masonry spanning the arches created a firm, stable platform, offering a wide space for gunnery.

Beyond these generalized uses of the casemates, the most frequent documentary references are to the existence of prisons and latrines, although the evidence is not entirely satisfactory and hence attribution of function to a precise location is not always certain. In 1727 Verrier reported that "I installed a prison in one of the large casemates, having ordered the necessary floors to be made there"[46] (author's translation), and several years later he lamented that the casemate prisons were so damp that prisoners fell ill and had to be taken to the hospital.[47] On the 1724 plan a latrine with a drain emptying into the ditch through the escarp of the face is clearly depicted in casemate 9R (Fig. 114), while an undated and unsigned plan of bastion indicated latrines in casemates 7 and 8R, prisons in 6R and 7L, and a powder magazine in 9R (Fig. 118). The representations of the gun embrasures on the flanks and the barracks in elevation do not conform to what, on the basis of other documentation, was in fact built, and therefore place this plan's date to the end of the 1720s or, at the latest, 1731, when work was resumed on the incomplete bastion. Following the first siege, repairs had been needed on a casemate floor and makeshift works had been erected in two casemates to protect prisoners from the constantly dripping water.[48] A slightly later account noted that:

> of the six [*souterrains*] located on the right flank of the King's Bastion, four serve as prisons, one as a latrine, another is empty, that which is beneath the right face is occupied by a soldier. Of the six others located on the left flank of the same bastion, one serves as a prison, another as a latrine and four are empty as well as the one beneath the left face which is in bad condition.[49] (Author's translation.)

The arrangement of the drain in casemate 1L is similar in some respects to that depicted in casemate 9R on the 1724 plan in which interior partitioning, a three-hole bench and an existing drain through the escarp are all visible (Fig. 114). In casemate 1L a rubble-stone bed supported the dressed-sandstone drain from one end of the casemate to the other, intersecting a transverse wall 2 m from the rear of the escarp (Fig. 121). The channel then continued through the escarp at an increased slope. As the whole area had been cleaned out by the previous restorers, it is not surprising that traces of less durable materials than stone were no longer present. There is no evidence, for instance, as to whether a partition existed above floor height on the transverse wall, or where any benches might have been located. Identification of the area as a latrine nevertheless seems reasonable on the basis of the 1753 statement and the existence of the drain; certainly no other casemate on the left flank would have suited the purpose.

By the same reasoning, the presence of a latrine at the right shoulder may be accepted, but there the situation is more complex. A drainage channel similar to that on the left flank extended through the rear of casemate 7R in one direction, and connected to drains in the floor of casemate 8R in the other. No opening was found on the escarp because of the extensive damage there. But from the repaired wall of 1755 came several sandstone pieces which re-assembled to form a drain opening almost identical to that found *in situ* on the left flank (Fig. 152). For the stones to have been incorporated in a major repair, the feature to which they originally belonged could no longer have been intact. We may conclude that the opening served the channel at the rear of casemate 7R, was dislodged during the 1745 siege, and its stones used as convenient repair material when the escarp was rebuilt, but the issue then becomes clouded. Once more, siege and demolition reduced the shoulder area to rubble. It is not certain how the area was drained in the later period.

If the 1753 report is taken as accurate in detail, a latrine was located in the right flank in one of the six full-sized casemates. A sandstone drainage channel in casemate 6R (Fig. 121) drained surface water from the terreplein, but the ruined condition of the casemate effectively ruled out any possibility of resolving where it led or if it was associated with a latrine.

Location of the areas designated as prisons is even more uncertain. If the chronological sequence of the documentary sources previously cited has any significance, it would appear that the number of casemates used as prisons varied from the one originally mentioned by Verrier to a total of five on both flanks in the 1750s.

In spite of the depth of the right flank casemates, little archaeological evidence supports the presence of floors at terreplein level in any of them with the possible exception of casemate 6R. There, severe damage to two of its four walls and the total collapse of its vaulted roof limited the investigation, but five large, rectangular cavities, spaced at fairly regular intervals, were still discernible in the best-preserved wall, the partition between casemates 5 and 6. Crumbling mortar and fallen or loose stones precluded precise measurements, but the cavities were originally perhaps 35 cm square and spacing was calculated at 1.5 m centre to centre. Joists set in these holes to span the casemate would, with planking over them, provide a floor at an elevation compatible with the surviving threshold. However, while the spacing would support an ample load without danger,[50] it was considerably wider than normal in the 18th century. Belidor, for instance, specified joists placed 2 *pieds* apart, centre to centre[51] while documentation referring to domestic buildings within the town of Louisbourg stipulates spacing of 3 *pieds*.[52] Although the walls of the other casemates did not yield evidence of joist holes or floors at terreplein level, they were by no means devoid of square, regularly spaced holes; however, these were much smaller, averaging only 15 cm square, and occurred at three different levels. Such features are most logically interpreted as putlog holes to support scaffolding during construction or, more likely, subsequent repair work.

Traces of wooden planking and beams were recovered from all of the right flank casemates except 2R, where rubble-clearing and stabilization work in the 1930s had removed all material to well below terreplein level, but only in one instance could the remains be positively identified as a floor. The bottom of casemate 1R had been filled with refuse and a floor, with joists running across the width of the casemate and remains of planking nailed to it, was found above this deposit (Fig. 153). The joists merely rested on boulders set in the underlying fill. The spacing of the joists, although somewhat distorted, was no more than 0.75 m centre to centre, in close accordance with the 2-3 *pied* spacing given in documentary sources. It is tempting to interpret the wood fragments found in the other casemates as floor remains, but the evidence is not conclusive. The traces recovered from 3 and 4R, while quite well preserved, were not associated with joists spanning the widths of the casemates, and the total area covered was too small to suggest flooring. Neither the damaged condition of casemates 5 and

6 nor the manner in which they were excavated held much hope for the recovery of detailed information, but from what observations were made, no continuous floors had been present. Considering the various references to repairs to the casemate walls after 1749 and to the expedients adopted in efforts to reduce the problem of constantly dripping water, the presence of quantities of wood other than for flooring is readily understood.

Scraps of planking and broken beams could as well have found their way into the casemates as rubbish, dumped into conveniently available empty spaces. Refuse lay under the floor in casemate 1R, and similar deposits were observed in the others too (Fig. 127). The inclined nature of the strata implied that large quantities of refuse were tipped in by the barrowload over the entire length of the casemates; the corollary of this is that at the time of deposition no floors existed to impede the process.

A final consideration is the intent expressed by the draftsmen of the 1724 and 1725 plans of the bastion (Figs. 114-116). The former plan does not use the conventional colour-coding to distinguish between work completed and work proposed, and hence does not indicate the degree of progress reached on the right flank. The "profil par la ligne AB" nevertheless shows the casemates to be deep, open structures with no upper floors and the lower levels accessible by substantial steps, presumably of masonry. The latter plan, on the other hand, is a very precise, detailed rendering of what Verrier found when he took over his new position. On the "profil pris sur la ligne JL," he was careful to indicate that the upper part of the rampart and the steps down into the casemates were not yet completed. No floor, completed or projected, is shown.

Any attempt to locate prisons by association with known floors on the right flank is therefore none too successful. The most specific documentary evidence is that of the undated plan identifying casemate 6R as serving such a function (Fig. 118). Some archaeological evidence lends credence to this location. The overlapping interior revetments of face and flank had blocked the original vent of casemate 6R to the west, on left, of the door, but remains of a flat-stone arch spanned the oddly angled north corner of casemate 8R and in the masonry immediately above, where the corners of casemates 6, 7 and 8 met, was a deliberately formed cavity. Taken in conjunction with a Y-shaped opening shown there on another undated plan of the bastion (Fig. 117), it was possible to conclude that the vent to the right of the doorway of casemate 8, instead of opening directly into the casemate, extended into the masonry above the arch and then branched in one direction into casemate 6 and in the other into casemate 7. Photographs from the preliminary investigations of 1962 show that located in the rubble in front of the vent opening on the right face was a barbed flat bar, while on the interior of casemate 6 the opening was barred with a flat, horizontal strap. It is more likely that such measures were taken to prevent prisoners escaping via the air vent from casemate 6 than to prevent persons from breaking into a latrine in casemate 7. The same series of photos also shows the location of four square wrought-iron bars in the rubble close to the doorway of 6R. No further record of their relationship to the nearby structures was made, but their length -- approximately 1.2 m -- and position suggested that they had once barred the vent to the east, or right, of the door. A *proces-verbal* concerning the escape of three prisoners in 1731 referred to barred vents: the prison in question had a vent *(soupirail)* that opened onto the "cour du fort," presumably the bastion terreplein, and was covered by horizontal bars on the inside and perpendicular ones on the outside.[53] Finally, the distribution of wrought-iron shackles, or identifiable portions thereof, from within the citadel, reveals a preponderance of finds from casemate 6R: of 29 objects of known provenience, 14 came from 6R, four were recovered on the terreplein, two from its well, four were found in casemate 5R, one in 1R, two in 7L and two in the barracks basement. The demonstrated use of the casemates as rubbish dumps reduces the force of the argument, but the circumstantial evidence for the use of casemate 6R as a prison is still strong.

Casemate 7L was indicated as a prison on the undated plan (Fig. 118). Also supporting this identification are the two shackle fragments listed above and possible traces of plank flooring, but it does not appear to have been in use after the first siege according to the 1753 report.

Beyond the evidence concerning prisons and latrines, little indicates what specific functions the casemates may have served when not being used as shelters in time of siege. Indeed, the most prevalent use seems to have been, at least for those on the right flank, as convenient areas to dump garbage. The steps indicated on Verrier's 1725 plan (Fig. 115) as to be completed, appear never to have been built. Certainly no traces were found during excavation and they were not included in the known *toisés*. Entering the casemates was probably not a frequent occurrence and could only have been accomplished by means of wooden stairs or ladders that have left no trace. To fill the damp space to a more accessible level was probably a practical solution to an immediate maintenance problem.

The casemates were at least indirectly involved in the bastion drainage problems. A hollow area completely enclosed by masonry walls, the terreplein had the potential of becoming a vast cistern in times of heavy rainfall or when the winter snows began to melt. Surface water was therefore channelled off in several directions and permitted to pass through the masonry shell at five different points. The drains beneath the sills of casemates 1L, 6R and 8R, leading eventually through the escarps to the ditch outside, have already been discussed. Whether the drains through 6R and 8R were contemporaneous or represented two separate construction phases associated with repairs to the ramparts in that area, they both received run-off from cobbled paving extending the length of the right flank in front of the casemates. The cobbles had been laid so as to form a shallow, open trough or gutter along the centre of the paving (Fig. 121), a design not uncommon elsewhere in Louisbourg. No such paving was evident along the left flank but the higher level of the original terrain might have provided a firmer surface sufficient to persuade the builders that drainage was less of a problem there. Certainly the drain in casemate 1L, passing as it did beneath the entranceway, was intended to receive surface run-off from the terreplein, and no means of channelling water to the drain had been installed.

Extending the length of the terreplein side of the barracks was more cobbled paving. A distinct trough immediately against the wall may have been due to the ground settling into the building's foundation trench rather than to design, as little purpose could be served by accumulating water against the base of the wall and allowing it to filtre into the cellars. At each extremity of the barracks paving, where the building adjoined the interior revetments of the flanks, additional drainage was provided by channels angled through the thick masonry terminating walls of the flanks. Extending the width of the rampart from the outer surface of the escarp to the interior revetment, each terminating wall delimited the flank and served as a side wall to the adjacent casemate in one direction, and blocked off the small townside ditch of the barracks in the other. It was into this ditch that the two end drains emptied. Set in masonry for almost their entire length, they had to be constructed so as to prevent water from being absorbed by the mortar surrounding them, hence the drains consisted of a series of carefully worked sandstones, each with a semicircular channel, set end to end and overlaid by identical stones inverted to form, in effect, a drainpipe with an internal diameter of 15 cm. The end drains had not survived on the ditch side, but since it would have been desirable to keep the water from cascading directly down the wall, the presence of short, simple spouts is likely. Curiously enough, the material for the small end drains is specifically recorded in the *toisés* under the amounts of sandstone cut for various purposes, whereas the larger drains through the casemates are nowhere mentioned. As is unlikely that the builders would have gone to the trouble of piercing tunnels through the ramparts and escarps after they had been completed, the larger items must have been omitted in the *toisés* or included elsewhere.

The hill on which the bastion was built was lower to the north than to the south and hence all natural drainage followed this direction. Water seeping below the terreplein level would find its way through the right flank once impermeable bedrock had been reached. In an attempt to channel this flow, the builders had from the beginning envisaged a "rigolle" from the base of the escarp out into the ditch, down to the pond in front of the Dauphin Bastion and eventually to the harbour (Figs. 71, 72). The lowest point, where the greatest accumulation of water occurred, was in the area of casemate 3R where the rubble-stone drain ran the length of the floor to exit beneath the escarp. The other end of the drain was cleverly located in the well of the terreplein. Thus the well, dug far below the rampart foundation levels, served as a catchment area to which all below-grade waters flowed and the drain through the casemate effectively maintained the level of the well water below foundation level so that no serious erosion would occur.

Thus the ramparts: an amalgam of masonry and earth, of solid fill and hollow chambers, providing shelter and security for those under attack. But to fulfil their function properly, ramparts had to support parapets that would shield the defence as they retaliated.

Parapets, Embrasures and *Guérite*

While structurally the parapets of the King's Bastion belonged to one unit, in terms of military disposition the part of the bastion to the left of the capital line bisecting the flanked angle belonged to one front, the part to the right to another. The relationship of the front will therefore be discussed later.

The approved system of developing bastions and horizontal fields of fire, as spelled out at considerable length in contemporary texts, was followed in traces of the Louisbourg defences and similar guidelines existed for the establishment of profiles although, somewhat curiously, less emphasis was placed on this aspect. The relative merits of various angles and dimensions were not disputed in the same manner as was the geometry of the trace. Authors most explicit in specifying dimensions are the engineers whose unpublished files, reflections of years of practical experience, are located with the Inspection du Génie.[54]

There appears to have been considerable latitude in design criteria, but certain principles do emerge. A parapet was to provide cover and a vantage point for defensive fire. It had to be thick enough to withstand whatever shot was thought capable of reaching it -- in the case of cannon, 15 *pieds* was specified as an absolute minimum,[55] with 18 or even 20 *pieds* being recommended by some authorities.[56] Unless otherwise specified, parapets were designed primarily for defence by musketry. The same thinking that gave rise to the concept of an ideal line of defence in trace obviously influenced parapet design: a man was supposed to rest his musket comfortably on the crest and fire blindly directly in front of him down the slope. For such fire to be effective,

> Normally 4 *pieds* and 4-6 *pouces* at maximum is accorded the parapet height, which should not vary greatly one way or the other: too high and the shorter soldiers would not be able to fire over it, their fire would not plunge sufficiently to defend the outworks and ditch and all their shots would be wasted; when the parapets are lower than 4 *pieds* 3 *pouces*, troops assigned to defending the outworks are too exposed to enemy fire which is a serious mistake....[57] (Authors' translation.)

The 4-1/2 *pieds* was not the total height of the parapet, but the vertical distance between the surface of the banquette (firing step) and crest of the parapet. In other words, the total height of the interior revetment of the parapet was reduced by the height of the banquette until the desired firing height had been achieved (Fig. 132). Dimensions varied, but a figure of 7 to 8 *pieds* for the maximum height of the parapet is often quoted. This is the height above the top of the rampart, referred to as the terreplein of the rampart (the exterior revetment, or escarp, was normally capped with a cordon stone, hence height "above cordon" is virtually synonymous with height above rampart terreplein). The exterior of the parapet would rise anywhere from 3-1/2 to 5 *pieds* and then slope to the interior, continuing up to its full height before dropping sharply to terreplein level (Fig. 132). The escarp was invariably built to a batter, but the parapet exterior frequently was retained by a vertical masonry wall; if not, it sloped back and was retained by carefully stacked turves. A masonry retaining wall served as the interior revetment; it may have been vertical, but is frequently shown with a slight batter.

As the superior slope allowed a soldier to fire without taking careful aim, the prolongation of the line of fire was of paramount importance to the defence's effectiveness; however, there does not appear to be complete agreement as to where this line would strike. The principle is perhaps best stated in these terms:

> The upper portion of the parapet slopes towards the country so that a soldier is able to keep an enemy in view when he is close to the [defended] place; the slope should not be too steep lest the interior crest of the parapet be too weak, but it should be steep enough so that the covered way is exposed.[58] (Author's translation.)

Thus the various 18th-century texts purporting to describe the exact method of Vauban all show profiles in which the projected line of the superior slope strikes the covered way, either directly on top of the counterscarp or anywhere on the horizontal surface. Cormontaigne favoured a line of fire that would strike the foot of the banquette of the covered way,[59] and Franquet's proposals for improving the defences of Louisbourg contain similar profiles (Figs. 90-93).

Clearly, the main concern was to bring fire to bear on an enemy who had won through to the covered way. The relationship of the glacis to the parapet was therefore of considerable importance and was specifically referred to by Chaussegros de Léry and Masse, who maintained that when extended, the slope of the glacis should theoretically strike the cordon or slightly above it in order to eliminate dead ground:

> Care must nevertheless be taken that the extension of the slope of the glacis does not go above cordon height, because if it is higher than the parapet, it will come about that the palisades [on the covered way] will obscure the foot of the glacis from the main defences, which should have an uninterrupted view over the glacis....[60] (Author's translation.)

However, the area at the extremity of the glacis was to be covered by artillery fire from embrasures let into the parapets of the faces of the bastions, and not by musketry fire.[61]

How were these general principles applied at Louisbourg? Documentary evidence is scant. Beyond the official correspondence referring to the completion of the parapets in 1731,[62] little mention is made, no detailed description were given by the original builders, and the *toisés* are missing. In spite of the 1731 completion date, work apparently continued for several years, since in 1733 Verrier reported that he had left a gap in the right face to allow earth fill to be brought in for the parapets and the terreplein of the rampart,[63] and a year later was complaining

> I have to honour of pointing out to your Lordship that in order to defend a place, parapets are necessary and by all appearances we won't have any for two years if the labourers responsible for laying the rampart fill quit their job next year at as early a date as they did this years....[64] (Author's translation.)

The only indications of the nature of the parapets are profiles through the ramparts drawn by Verville and Verrier as work proposals, not as work actually completed (Figs. 111, 113-116). Verville's earliest concept (Fig. 111) indicates a parapet with no exterior revetment of masonry, and therefore sloping back from the cordon; the prolongation of the superior slope strikes the top of the counterscarp. This design was abandoned in favour of a vertical masonry revetment above the cordon (Figs. 113, 114). In his later plan the proposed configuration of the covered way and part of the glacis is shown, and the superior slope of the parapet is in direct alignment with the slope of the glacis. The same alignment is indicated on Verrier's first plan (Fig. 115).

Upon the return of the French in 1749, Boucher inspected the fortifications, gave a brief, general description, and prepared estimates of materials needed to repair the works, but included no details of help in determining what he found or what he proposed.[65] Franquet's correspondence contains more detail and is accompanied by several plans and profiles,[66] but this evidence present serious problems of interpretation and can only be used within narrow limits. It is difficult to differentiate between what he found and what he proposed.

Nevertheless, the general appearance of the parapets is clear. In keeping with the time-honoured tradition of fortification architecture, the upper limit of the escarp was delimited by a cordon course. Above this, the exterior revetment of the parapet, built in rubble masonry, rose vertically until the alignment of the superior slope was reached.

The parapets of the faces were not of the same design as those of the flanks. The former consisted of an uninterrupted mass of earth, retained at the rear, as well as at the front, by a low masonry wall, against which an earthen banquette was laid to permit troops armed with muskets to fire down the slope of the parapet. On the flanks the parapets were interrupted by embrasures for cannon. To allow for operation of the guns and their considerable recoil, the rampart terreplein was much broader, and hence the parapet much narrower, than on the faces. No banquette appears to have been incorporated in the flank design.

The number of embrasures on each flank is not clear as there is no consistency in the earlier plans. Verville's plan of circa 1718 (Fig. 111) indicated five embrasures on the left flank and six on the right. Verrier's earliest plan (Fig. 115) called for seven on each flank; however, his plan of 1730 suggests that he had reduced the number to six. Such modification is quite understandable in the light of what was then considered sound design: too close spacing of embrasures would result in weak merlons (the solid part of the parapet between embrasures) and would restrict manoeuvrability. No later datable plans specifically related to the King's Bastion alone have been found; all post-1730 plans depict the fortifications as a whole and as such are possibly less concerned with fine detail. Nevertheless, six gun embrasures are represented on each flank of the King's Bastion on all of these plans.

The weight of evidence is in favour of a change in design prior to construction, with six embrasures being built on each flank, but the case is not watertight. An unsigned, undated plan of the citadel (Fig. 118) unequivocally shows seven embrasures on each flank yet the way in which other elements of the citadel, in particular the roof-line of the barracks, are depicted suggests a date of 1731 to 1732 for the plan. More disturbing -- indeed inexplicable -- is Boucher's 1749 work estimate for "the 7 embrasures to be rebuilt on the right flank of the King's Bastion as they were before."[67] (Author's translation.) On the other hand, Franquet proposed thickening the parapets on both flanks and reducing the number of embrasures from six to five,[68] and in 1744 Verrier had recorded as items to be covered by extra expenses six hurters, placed on the *genouillères* of the right flank embrasures.[69]

On balance, the weight of the evidence supports the conclusion that six embrasures had been built on each flank.

Other differences between the parapets of the faces and those of the flanks were implicit in the nature of the ramparts beneath rather than in the function of the parapets themselves. The casemates in the flanks created special problems of drainage which the builders hoped to eliminate by laying a platform or paving of carefully squared sandstone blocks -- "pierres de taille" or "free-stone" in the terminologies of the French and English engineers who recorded the feature.[70] Franquet's observations added the information that the paving stones were laid with an "arrette" or central spine forming a watershed. The extent of the paving and general appearance in plan was probably close to what Verrier depicted in 1730 (Fig. 119); however, in profile he showed a constant slope to the exterior. Although all of the loose material had been removed from above the surviving casemates in the course of the various attempts at restoration earlier this century, during the excavations in the area of the right shoulder and in the ruins of casemates 5 and 6R it became apparent that not only were large sections of collapsed vaulting present, but also several stones from the platform above (Fig. 154). Within the group were found several cut with a distinct ridge on the upper surface -- Franquet's "arrette" -- which, set in the centre of the platform, would have created a watershed. Water flowing to the interior revetment would have found its way down to the open drainage channel in the cobble paving in front of the casemates and eventually out into the ditch via the drain behind casemate 7R. No evidence indicates any form of gutter.

Water flowing the other way would presumably have been channelled through the parapet by spouts although no such stones were found within the citadel nor is there any documentary evidence as to how this issue was resolved. However, spouts were recovered in the course of excavations at the Dauphin Bastion and were used at the extremities of the drains from the paving in front of the barracks. The use of spouts on the ramparts of the citadel would conform to the pattern of construction observed elsewhere at Louisbourg and common throughout Europe at the time. Whatever method was employed was scarcely satisfactory: the casemates leaked continually and countermeasures were not entirely successful.

The casemates influenced rampart design in another way also. With entrances all along the interior revetments of both flanks, access to the rampart terreplein was limited to the faces. Two gradually sloping ramps met at the flanked angle as they rose from the terreplein of the bastion on an alignment parallel to the interior revetment of the faces. The ramps consisted of compacted earth retained by a masonry revetment similar to the interior revetment of the ramparts. The slope was gentle enough to permit cannon to be hauled up to the rampart terreplein and all personnel had to follow the same route since no steps were provided.

Also located at the flanked angle was a barbette battery allowing the defenders to fire cannon over the parapets of the faces rather than through embrasures. While the gunners would be more dangerously exposed than those at a lower level, they had the advantage of an elevated position to cover the approaches beyond the glacis that would not be in the line of fire of embrasures; the barbette was thus for long-range firing before the action became too hot. Although the existence of the barbette is established beyond doubt in the documentation and is clearly depicted on a number of plans (Figs. 114, 116), no surviving remains were located at the flanked angle, the ramparts having been demolished to well below the level at which it would have been situated. Precise dimensions are a matter of conjecture, limited to *toisé* estimates presented, as usual, in averaged volumes of masonry; however, the platform would have been almost as high as the crest of the parapet in order to enable a gun on a carriage to fire freely, and the platform would have been wide enough for gun crews to operate effectively. Ramps leading to the platform from the terreplein of the rampart would have been inclined gradually enough to permit the hauling of guns.

In any attempt to determine more precisely the dimensions of the parapets, the necessary datum is provided by the magistral line, usually synonymous with the cordon level. The assumption must therefore be made that the King's Bastion was in fact built with a horizontal magistral line or cordon at a constant elevation. There is no explicit evidence for this, but if such were the norm, it is less likely to have aroused comment than any deviation from it. There are, however, ambiguous references to changes of elevation. Franquet's description of the fronts on either side of the Queen's Bastion makes it clear that the faces of this bastion sloped down from the flanked angle to the shoulders, and that the right flank in turn sloped down slightly towards its junction with the curtain. Unfortunately, he then commented that the flank was 14 *pouces* higher than the face, which would mean a very peculiar and unlikely juxtaposition of walls. The issue is further complicated by his observation that "the left flank of the King's Bastion has also the defect of being higher than the left face of this [the King's] bastion.[71] (Author's translation.)

It is nowhere clear at what point these measurements were taken. Does Franquet refer to the magistral line, the superior crest of the parapet, or the terreplein of the rampart? Moreover, he was inspecting fortifications he had not seen before, fortifications that had withstood enemy fire, had been repaired in makeshift fashion by an occupying force, and had deteriorated considerably because of the climate and lack of attention. Were his references to differences of height a reflection of these factors?

In the absence of any fool-proof method of ascertaining exactly what Franquet meant, the most prudent course is to consider each of his references, whether written or drawn, on its individual merit; where it can be cross-checked by reference to other sources, either contemporary documentation or field measurements, it can be of use. Where no such verification exists, it would be unwise to accept his observations for what they appear to say.

Thus the initial premise -- that the magistral line of the King's Bastion was at a constant elevation -- is still retained. A determination of this level is essential before any further calculations may be made. The lower limit is established by the surviving casemates: the rampart terreplein could not have been lower than the top of their arches. It is frustrating to realize that the actual level of the terreplein on both flanks could probably have been recorded at the time of Kennelly's stabilization programme; instead, a general statement is all we have:

> the work of protecting the ruins ... was undertaken in November, 1903, by the removal from the roofs of the two sets of the bombproofs (north and south), of some of what had been the protecting covering of stone and earth, of about the thickness of three feet....
>
> In 1904 work was resumed on May 27th, and continued down to December 30th. The roofs of the bombproofs were completely stripped to the stonework of their arches, well cleaned, and a blanket of cement, about three inches in thickness, was laid over the roofs.[72]

In other words, what survived after the stabilization work was considerably lower than it had been before. It also follows that any discrepancy in elevation between the surviving left and right flanks is a reflection of the stabilization work, not the original construction. In their stabilized state the casemates stood to a maximum of 15.16 m above mean sea level on the right flank, and 14.90 on the left.

Unfortunately, only once did the French engineers actually use a baseline tied to sea level. In his original specifications, Verville proposed resting the cordon on ground level at the highest point of land, which would then become the flanked angle of the King's Bastion. This became his zero line and in the profiles he established across the terrain he indicated that the line was 45 *pieds* 9 *pouces* above sea level,[73] but clearly this initial concept was revised. His elevation would only be 14.87 m above sea level, and when 0.8 m is deducted to adjust the figure to present-day sea level, his magistral line drops even further below the minimum elevation allowable from the casemate readings.

Various methods of re-establishing the elevation may be attempted, all of them involving the addition of historically deduced averages to archaeologically attested elevations, and none of them exact. To the surviving height of the right flank casemates, material equal to the thickness of that purportedly removed in 1903 may be added, or alternatively the amount of material typically specified on top of the *souterrains* plus the thickness of the free-stone paving may be calculated. Working from the bottom up, the *toisé* average heights of masonry may be added to the elevation of the base of the walls as found; separate calculations may be made for the escarps, the interior revetments, and the casemates themselves. Calculations based on historical and archaeological measurements from the flanks of the bastion appear to be the least susceptible to distortion, and indicate an approximate elevation of 15.7 m above present-day mean sea level for the magistral line. (*See* Appendix C for details of the calculations.)

Returning to the original premise that the magistral line was at the same elevation throughout the bastion, the form of the parapets takes on greater definition when further dimensions are applied to the magistral baseline. As the parapets of the faces were different from those of the flanks, the evidence for the two sets is reviewed separately.

In the rampart fill of the right face, slightly behind and above the rear wall of the casemates, were the remains of a masonry wall (Figs. 131, 147). Its alignment parallel to the interior revetment and the escarp, its distance from the escarp, and its elevation, somewhat below the level of the rampart terreplein, all favoured the conclusion that this was the base of the interior revetment of the parapet. Projecting the slope of the escarp to the magistral line, the horizontal distance from the masonry remains to the outer surface of the escarp would be 6.5 m, which corresponds very well with the 20-*pied*-thick parapet originally specified by Verville[74] and entirely compatible with those proposed by Verrier (Figs. 115, 116). Little else could be deduced from the surviving remains. No indication of the total height of the wall was left, nor could it be determined if the wall were vertical or slightly inclined towards the country although most documentary sources suggest a slight degree of batter to such a wall. Such a design may clearly be seen in Verrier's profiles. Chaussegros de Léry is apparently the only authority who specifically objected to this practice, maintaining that it obliged soldiers to lean too far forward, putting them off balance when firing.[75] All authors insisted upon very close limits for the height of the interior revetment of the parapet: usually 4 *pieds* 6 *pouces* to the crest from the top of the banquette. Similarly, they generally agreed on the dimensions of the banquette itself: 3 *pieds* high with a level terreplein 6 *pieds* wide, and sloped over a distance of 3 *pieds* down to the rampart terreplein.

Sometimes the permissible range of dimensions was expressed another way: the total interior height of the parapet from rampart terreplein to crest was to be between 7 *pieds* and 7 *pieds* 6 *pouces*. The upper 12-18 *pouces* of the revetment were to be of turf to provide a better rest and to lessen the danger of enemy fire causing masonry fragments to fly in all directions. There is no reason to doubt that these specifications were respected in this case.

Calculations based upon other evidence relating to the superior slope provide a close correlation. The incline of the superior slope depended on the difference in height between the interior revetment and the exterior revetment of the parapet. Recommended heights for the latter vary between 3 *pieds* 6 *pouces* and 6 *pieds*. What governed the choice of height and is there any way of repeating Verrier's calculations?

The majority, if not the entirety, of fortifications treatises insist that the slope of the parapet, when extended, strike the covered way. The reason is not hard to understand: the taking of the covered way was often the most hotly and bloodily contested stage in a siege. An enemy, relatively well covered in trenches, would slowly, inexorably work forward until no obstacle remained between him and the main *enceinte*. From the covered way the decisive breaches and, if necessary, assaults could be made, but the defence, with the advantage of both commanding height and protective parapets, could well hope to delay or even reverse the issue by making the covered way untenable. However, Verrier's 1725 plan shows quite explicitly that it was his intent to build the slope of the parapet in the same plane as the slope of the glacis. Furthermore, by projecting the line of the parapet shown on Verville's revised plans, it is clear that this was his intent also. Where they at odds with military practice, ignoring a fundamental element of fortification design?

Chaussegros de Léry provides an insight. A strong advocate of pouring as much fire-power as possible onto the covered way, he even recommended including gun embrasures so as to allow cannon, their muzzles fully depressed, to augment defensive fire. He was much exercised with the whole question of defence in profile and armed his dissatisfaction with the lack of attention commonly given to this aspect of existing fortifications. Unlike Masse, who discussed the same topic less dogmatically, Chaussegros de Léry insisted that the prolongation of the glacis slope strike the parapet at cordon level. Any higher, and dead ground would develop towards the end of the glacis. But he added an important qualifier: if the slope of the parapet was to provide fire onto the covered way, then the glacis should be swept by artillery firing through embrasures in the same parapet. An alternative alignment was considered:

> It could be argued that, in the case of a steep glacis, the extension of its slope could meet the exterior crest of the parapet, permitting the glacis to be swept with fire and thus ensuring better protection to the place, on the understanding that musketry from the place and on the covered way would not be in action at the same time but [initially] only on the covered way; to which I reply that this could be done if no artillery was intended for the ramparts, but since it is essential to destroy enemy siegeworks and to hinder an attack, I believe it is better to follow the proposals I have just made, because such artillery fire is so advantageous.[76] (Author's translation.)

The situation at Louisbourg -- no artillery on the ramparts of the faces and the parapet slopes in alignment with the glacis -- was not what had originally been planned. While the structure shown on Verville's plan of circa 1718 (Fig. 111) resembles superficially that which was later built, several important differences may be observed. The parapets are more squat and lack exterior revetments, the superior slope is directed onto the covered way, and gun embrasures are intended to be set in the parapets of the faces as well as the flanks. By 1720, however, several changes had been decided upon (Fig. 113). The glacis is not shown as a completed project, but as broken, sloping ground, and the proposed embrasures on the faces had been abandoned and, with them, the means of commanding the glacis. The parapet therefore had to be realized to regain this command. We can only speculate upon the reasons for the changes. Verville had already been cautioned not to design an elaborate *enceinte* such as would be suited to a European context. Also, the likelihood of having to withstand a full-scale siege "en règle" must have seemed remote, both from a logistical point of view and from the difficult nature of the terrain in front of the walls. It is clear that he committed himself to relying on musketry as his principle source of fire-power to defend against a direct attack; it is equally clear that Verrier shared his opinion and continued with the same design. They had thus created just that situation of which Chaussegros de Léry disapproved. To improve such dispositions, he argued, involved little time and effort: all that was required was to raise the crest of the parapet by one *pied* or so and to lengthen the slope of the glacis to realign it on the cordon. Franquet's criticisms and proposed improvements become much clearer in the light of Chaussegros de Léry's argument, for Franquet complained that the parapet was 1 *pied 6 pouces* too low and that the glacis also needed raising: his recommendations could have been taken straight from Chaussegros de Léry's text. The profiles he drew through the faces of the King's Bastion reveal his intent to raise the crest of the parapet, thereby altering the slope so that it would extend onto the covered way, not the glacis. Similarly, the slope of the glacis was to be altered and extended to at least twice its original length.

Excavations revealed not only that the glacis had not been modified by Franquet or anyone else, but also that it had never really been completed in textbook form. Measuring the contours at close intervals revealed many irregularities and the degree of slope was not constant in several sections. The closer the area in front of the right shoulder of the bastion was approached, the more irregular the surface became. The reason was not hard to find: the original hill on which the bastion was located had its highest point on the interior of the bastion near the flanked angle, but an outcrop of ground almost as high was located to the northwest and overlooked the general slope of land that continued down into the boggy ground and, in a more northerly direction, into the pond in front of the Dauphin Half-Bastion. No glacis could be laid out in a regular fashion to accommodate such uneven terrain, and the effort of levelling the ground would have been enormous. The builders arrived at a workable compromise, using the natural hillside as the glacis in front of the right shoulder and re-entrant angle. Since the steep, irregular slope down to the bog and pond could not be seen from the ramparts, a modified form of *place d'armes* was added to the covered way at this point, extending along and slightly below the ridge of the outcrop. Because of the rapid drop over a short distance, the left face of the *place d'armes* was appreciably higher than the right. The ground did not permit a regular triangular *place d'armes* to be formed, the two faces being close together and converging only gradually. In order to avoid a long, tapering salient so narrow as to be useless, the *place d'armes* was given a rounded salient. Of unusual design, it nevertheless represented the most economical way of covering a potential blind spot in the defences, and even Franquet acknowledged this point. Its major shortcoming was that the high left face left its defenders completely unprotected from the rear.

The glacis immediately to the left of the *place d'armes* incorporated a shallow natural gully probably formed by a fissure in the underlying rock. No attempt to fill and level the depression was ever made, for although an enemy lodged in it would be invisible to defenders on the ramparts, he would be exposed to fire from the *place d'armes*, which would only be abandoned with the covered way.

Closer to the flanked angle, the glacis became more regular as the natural terrain levelled off and reverted to flat peat-bog. Off the left face, the glacis had a uniform appearance and more precisely defined slope. Under such circumstances, it is not surprising that the degree of slope was not the same in all areas. Even under ideal circumstances, the laying-out of a glacis must have been a complicated exercise, for the distance from the counterscarp to the escarp was not constant, but gradually widened the further to right or left from the flanked angle it extended, and frequent adjustments had to be made to maintain the alignment of the slope in constant relationship to the ramparts.

It would be disingenuous, if not dishonest, to pretend that a perfect correlation between glacis and parapet had been established on the basis of our examination of the glacis, or that measurements could be taken with such precision as to substantiate the calculations used to establish the height of the cordon. The glacis was in origin quite irregular and had been sufficiently disturbed in later periods to yield different degrees of slope even on the same alignment. However, based upon measurements of slope in the most undisturbed and uniform sections, two conclusions may be drawn. The degree of slope varied between one in seven and one in nine off the right face of the bastion and between one in nine and one in eleven off the left face, and, secondly, a projection of these slopes passed through the point where the crest of the glacis would have been, assuming a standard banquette and firing height on the covered way, and passed over the deduced cordon height of the bastion by more than a metre (see Appendix D).

The latter conclusion reinforces the argument that Verrier had indeed built glacis and parapet on the same plane. Further corroboration is provided by Franquet's profiles (see Appendix B). His proposed modifications are superimposed on the outlines of the existing features; the original, unmodified slope of the parapet is seen to be on the same alignment as the slope of the glacis (Fig. 91). Lengthening the glacis and raising the superior crest of the parapet would alter this relationship.

It is clear that Verville and Verrier both adhered to one school of thought and Franquet to another. That such differences were reflected in actual construction in different places is implicit in Chaussegros de Léry's arguments. Disregarding extreme cases in the Alps or the Pyrenees in which the ground is so steeply scarped as to preclude a regular ditch and glacis, a similar relationship between parapet and glacis exists at Montmédy (Meuse). There a front of the fortifications overlooking the lower town commands a hillside sloping steeply down to the fields and habitations below, and the glacis merges indistinguishably with the natural lie of the land. The parapets of the small bastions forming the front are all aligned to sweep the glacis and hillside, not the covered way.[77]

The glacis alignment had no bearing on the height of the parapets of the flanks of the King's Bastion since they commanded the ditches rather than the glacis. Evidence regarding both the slope of the parapets and the angles of the gun embrasures was obtained from analysis of the approximately 200 dressed sandstones recovered from the dismantled escarp of the right flank. Twenty-seven conformed to the characteristics of stones in typical embrasures illustrated in the various authorities and still surviving in 18th-century works in Europe. The argument that the wall in question was the escarp Franquet rebuilt in 1755 has already been put forward, as has the corollary that any identifiable reused masonry fragments must date from the original construction. The presence of a substantial number of embrasure stones in this group is taken to mean that they were stones from the parapet above the escarp which had been "entierement demoly jusquau Cordon" according to Boucher, and is largely the basis on which the form of the parapet is deduced.

Using Verrier's 1725 and 1730 plans as a basis for the width of the parapets of the flanks, it was possible to incorporate the identifiable embrasure stones into a conjectural model of an embrasure (Fig. 145). The various permutations of the dimensions and the relative value of the different postulates contributing to the design are discussed in Appendix C.

It would appear that at least in designing his flank parapets Verrier was in accord with the criteria set forth by Chaussegros de Léry, who maintained that unless space restrictions absolutely obliged an engineer to design an even narrower parapet, the minimum permissible width was 9 *pieds*, as exemplified by his "Type 1" parapet: "a parapet 9 *pieds* wide pierced with embrasures; these should only be built in situations where any enemy fire will be from a great distance away...."[78] (Author's translation.) Under these conditions the merlons would have to be built in solid masonry, as earth would not be stable. The distance between embrasures, centre to centre, should be "une distance raisonnable," a minimum of 15 *pieds*, increasing in proportion to the width of the parapet. Six embrasures, equally spaced along the flanks would be roughly 16 *pieds* apart.

The flanks of the King's Bastion were presumably intended to be exposed to artillery fire from afar, if at all. The degree of slope to which the soles of the embrasures had been built demonstrated that the right flank was intended to command the low-lying ground between the King's and Dauphin bastions, requiring that the cannon be depressed more than on the left flank.

It is clear that in all respects Verrier's design corresponded closely to the general principles of the day. The height of the parapet above the paved terreplein of the flanks was considerable, but not excessive when compared to the profiles illustrating Chaussegros de Léry's texts, and it offered some measure of protection against reverse fire.

That Verrier had structural problems with his parapets, and the embrasures in particular, is nonetheless apparent , in part from the archaeological evidence, but largely from documentary sources. As early as 1734, the engineer found to his dismay that the coping stones of the embrasures, although they had been "cramponnées," were heaving in the freezing weather, and he felt that turf to a thickness of 1-1/2 *pieds* should be added to remedy the situation.[79] Use of wrought-iron crampons to hold stones together was widespread at Louisbourg; the characteristic shallow, rectilinear channel terminating in a deeper, square hole cut into the soft sandstone is readily identified on a variety of dressed stones. In the embrasures of the right flank the crampons had been applied both horizontally and vertically in an effort to preserve stability. The crampons would have been held in place with lead flashing as they were elsewhere on the site (see "Dauphin Half-Bastion: Parapets").

The use of turf in fortifications, particularly for lining the parapets, was a widespread and time-honoured practice favoured by all authorities on military architecture. Under normal condition it was the superior ability of a turf wall to withstand enemy shot without shattering into lethal fragments or collapsing in large sections, as masonry was wont to do, that recommended itself. At Louisbourg, use of turf as a capping material was resorted to as an expedient to protect the masonry from the rigours of climate, and it appears from the correspondence that this application was experimental, the benefits only gradually becoming recognized. Documentation from 1738 and 1739 indicates a general policy of turfing all the ramparts throughout the defences, and establishes beyond reasonable doubt that the flank parapets of the King's Bastion had been so treated.[80]

Exactly what the work entailed is not clear. In his proposals for the Island Battery, Verrier unequivocally specified the removal of several courses of masonry from the tops of the parapet, including the embrasures, and their replacement with layers of turf (Fig. 233). For the King's Bastion, no such clear-cut proposals were made and the turf was to be added to the masonry. The fact that stones from the top courses were found lends substance to the argument that no masonry was removed, but how and to what depth the turf was added cannot be determined.

The *guérite* was a common, if not indispensable, feature of fortifications from at least the 16th century until the 19th, and was certainly a hallmark of any Vauban-designed work. Whether, strictly speaking, it was considered a functional or ornamental element seems largely a matter of personal preference. A *guérite* set at the flanked angle provided a vantage point projecting beyond the parapet for a sentry to survey the ditch along both faces of a bastion and along an entire front of fortification. In some cases, *guérites* were also located at shoulder angles (Brouage being the classic example [Fig. 155]). Initial plans of the King's Bastion suggested three *guérites*, but the later, more reliable plans show only one. Boucher specifically referred to the *guérite* (singular) of the bastion, which had been destroyed to its base during the 1745 siege.[81] Beyond this, no details are known.

Three sources in particular -- Belidor, Chaussegros de Léry and Masse -- give general descriptions and illustrations of *guérites*. As the sources are all in harmony, one description will suffice:

> Guerites are built on the rampart and are normally placed at the angles of bastions, *demi-lunes* and other detached works; they are made of masonry and may be round, pentagonal or hexagonal [in plan] with an interior diameter of approximately four *pieds* and a height of six down to the start of the cantilevered base; they should have four to five little openings to permit the sentry to observe the bottom of the ditch, the covered way, and the other outworks.[82] (Author's translation.)

From the sources and an examination of extant *guérites* in France, it was possible to identify four stones found amidst the rubble in the ditch near the flanked angle as coming from a pentagonal *guérite* and draw a hypothetical model of an entire *guérite* (Fig. 156). Access to the structure must be a matter of conjecture, based on the 1730 plan showing steps down from the barbette to a passageway between the parapets of the faces (Fig. 119).

The Gorge of the Bastion: Barracks and *Place d'Armes*

The King's Bastion was transformed into a citadel by the structures that closed its gorge from the town. The large and imposing barracks, built entirely of masonry to the height of the ramparts, did not in itself constitute a military obstacle; its walls were not unduly thick, its glazed windows were not designed for defence and no loopholes appear to have been provided for musketry. It was physically separated from the town by a ditch which could only be crossed by drawbridge, but its designers can scarcely have placed any confidence in its capacity to resist an enemy who had progressed so far. The only element that could seriously be accorded any military value lay beyond the ditch. The counterscarp retained a small covered way which ran parallel to the axis of the barracks and swung back at a right angle at each end to meet the flanks of the bastion. Opposite the centre of the barracks, the covered way was expanded to form a *place d'armes* which screened the drawbridge and barracks entrance. Unlike the *places d'armes* of the outworks in front of the *enceinte*, the townside one was designed with short flanks and thus conformed more to the plan of a *demi-lune*. The covered way had a parapet which in turn commanded a short glacis, laid out in conformity to the plan of the covered way. Access to the barracks was thus limited to a small passage through the glacis and across the *place d'armes* to the bridge.

Because it was enclosed within defensive works and served a primarily military function, the barracks may be considered as part of the fortification; however, from an archaeological point of view, investigation of the building added little to our knowledge of the way in which fortification principles were applied or of Louisbourg's defences. The residential, religious and official functions for which the structure was destined are fully discussed elsewhere.[83] The potential for useful information of an archaeological nature had been severely limited by extensive restoration work in the 1930s, which in turn led to an assumption at the beginning of the present programme that no significant areas of the building had survived undisturbed. As a result, the stabilized foundations were cleared of their earth and rubble fill with only a cursory regard for normally accepted archaeological controls before it was realized that undisturbed material was in fact present (Fig. 158). Discussion of the finds properly belongs to a comparative study of French colonial life.

From both archaeological and military points of view, the covered way and *place d'armes* facing the town formed an interesting feature although it too had suffered considerable disturbance. The counterscarp of the ditch had been exposed during the 1930s work on the barracks and thereafter had been allowed to collapse. The foundations of the guardhouse which controlled access to the drawbridge had been exposed and stabilized. The glacis and covered way in the vicinity of the left flank of the King's Bastion had been obliterated by a roadway from the museum across the *place d'armes*, over the southern wing of the barracks and into the bastion. Taking advantage of the light protection against the wind offered by the covered way and glacis, 19th-century inhabitants had nestled a house into the glacis below the left shoulder angle of the *place d'armes*, making liberal use of building material from the adjacent ruins for their foundations, and another house was situated on the right flank.

Excavation nevertheless revealed evidence of a carefully conceived defence of the citadel entrance. Leading from the town, a dirt road was cut through the glacis of the left face. The sides of the passageway were revetted in rubble-stone masonry which increased in height in accordance with the slope of the glacis. The roadway was widest at the foot of the glacis, but to reduce the danger of enfilade fire, tapered and curved as it approached the covered way until it was only 3.35 m wide. The base of the revetment of the covered-way parapet extended into the entranceway from both sides, effectively constricting the opening still further. From a single, squared sandstone block found in the vicinity, cut to form a deeply inset, or rusticated, joint with other stones, it was presumed that the rubble masonry bases had been surmounted by sandstone pillars on which would have hung a gate or *barrière* some 1.8 m wide.

It was evident from the rise in the ground from the covered-way terreplein to the parapet revetment that a banquette had existed, but nowhere was a clear-cut definition of such a feature discernible. Calculating the possible height of the crest of the glacis and deducting from this the established elevations of the covered-way terreplein, it could be seen that the unit as a whole was not level, but sloped down from the barracks towards the town and from its right flank towards the left, in conformity with the original lie of the land: a drop in elevation of approximately 1.4 m along the covered way from the bridge to the extremity of the left flank, 61 m away, and 1.83 m from the bridge to the interior of the flanked angle, a distance of 51.2 m. (No reliable calculations could be made in the right flank sector because of extensive disturbance.) The slope from the points at which the flanks of the *place d'armes* rejoined the covered way to the flanked angle were more gradual than the decline in elevation along the capital line -- a drop of only 1.22 m in 49.7 m on both sides -- indicating that the area immediately in front of the bridge had been raised higher than the terreplein of the covered way. To achieve a relatively level surface, the builders had been able to work on the original ground surface in some areas and had been obliged to bring in fill in others, although no attempt was made to raise the northerly sector as high as the southerly one. In effect, the problem of ground was similar, although not so extreme, to that encountered in the *place d'armes* off the right re-entrant angle of the King's Bastion: one side was vulnerable to reverse fire. To compensate for this, it would appear from the stratigraphic evidence that the banquette was not at a constant height; as the ground rose, the banquette became lower to maintain reasonable cover behind the parapet.

The French scrupulously adhered to another principle of defence for the covered way in installing a palisade around the entire work. The palisade, set in the banquette, ran parallel to the parapet revetment at a distance of approximately 45 cm from the wall. Post-moulds for the individual stakes were clearly distinguishable (Fig. 159).

A more determined effort to counter problems of enfilade was made in the *crochets*, or off-set angles where the flanks of the *place d'armes* rejoined the covered way. To left and right, masonry-revetted traverses of earth were installed on the terreplein of the covered way, thus restricting the extent of the work that could be enfiladed at any one time from a given direction.

It is clear that the townside defences were intended as a serious military work, providing a line of retrenchment for the gorge of the King's Bastion. It is considerably less clear what form of attack its designers felt it should be able to withstand. The glacis was too low and too short to offer any protection against artillery located anywhere within the town; from any direction, the glacis dwindles to insignificance compared to the barracks towering above it. It would permit the garrison to withstand an assault from lightly armed troops approaching from the town, but this would presuppose an unlikely scenario in which a landing party had managed to come ashore unresisted within the town. Yet such a party would surely be large enough to overrun the small covered way and glacis, and the barracks would not offer a very secure line of retreat. On the other hand, as originally conceived, the town had virtually no defensive works to seaward, and it could well have been thought desirable to give at least the semblance of strong, all-round defence to the citadel. Verrier's own words perhaps best express the sentiment:

> Nothing now remains to be done to the defences except to complete the little covered way of the barracks on the side facing the town so as to safeguard the entrance to the barracks and the gorge of the King's Bastion should the need arise, and to give an appearance of strength to this bastion....[84] (Author's translation.)

The Dauphin Half-Bastion

Description and History

The half-bastion that closed off the landward *enceinte* on the harbour shore played a vital role in the designs of the military engineers. From the beginning, Verville's plans indicated the dual purpose of the work: to form, with the right face and flank of the King's Bastion, one landward front, and to sweep the sheltered waters of the harbour immediately below the town. By 1720 (Fig. 71) the form the structure would take was clearly established and was to remain unchanged in its essentials until 1745. The damage to the King's Bastion during the first siege and its subsequent modifications were slight compared to those inflicted upon the Dauphin Half-Bastion, which underwent considerable changes to both form and function as a result of the siege.

Designed on the landward side to conform to the traditional bastioned system of fortifications often referred to simplistically as the "Vauban system," the Dauphin Half-Bastion comprised a left flank and face that complemented the right flank and face of the King's Bastion, thereby forming, at least in trace, a normal fortification front. To the right of the flanked angle, the remaining distance to the shoreline could not be flanked in the regular manner and so was designed as a "front tenaillé," not uncommon in the 16th century,[1] but generally not approved of by 17th-century writers. Weak though it was, the tenaille front was the only direct means of defending a crucial element of the fortification: the Dauphin Gate, the principal access to the town by land. The gateway was set in the tenaille front, but even so was outside the perimeter of the bastion since the interior of the bastion was closed off from the shoreline by a curved wall, the junction of which with the rear of the tenaille escarp effectively excluded the gateway from the rest of the works. Referred to variously as the Circular, Semicircular or Horseshoe *(fer à cheval)* Battery, the curved wall was also reminiscent of fortification forms at the onset of the bastioned system. Extending from the tenaille front to the junction of the left flank and the curtain wall, the Circular Battery was considered an essential element of the harbour defences. Verrier did not feel that the port would be safe without it, even though the Island and Royal batteries were designed specifically to guard against a naval surprise attack.[2] Through the wall of the battery near its junction with the flank, an entranceway allowed controlled access to the interior of the bastion, where two buildings were located. The longer of the two buildings, against and parallel to the rampart of the left face, appears on plans as either a "cazernes" or "corps de garde"; it was evidently intended to serve as quarters for the small detachment of troops stationed in the bastion. The smaller, square building beside it is consistently identified as a powder magazine.[3]

As a reflection of the importance of the Dauphin Gate, two further guardhouses were located outside the bastion against the rear of the tenaille front, one on each side of the road through the gateway. Tucked between the tenaille and the wall of the Circular Battery, the larger structure housed the soldiers of the guard; on the other side of the road, set in the angle between the tenaille and the quay wall, the smaller structure was reserved for the officer. Both guardhouses were in effect lean-tos against the tenaille wall in which loopholes were pierced to allow musketry fire to cover the entrance approaches. The gate itself was a massive ornamental work true to the tradition of French fortifications, except that no superstructure supporting a guardroom and portcullis or *orgues* was envisaged. Decorative columns flanked heavy double doors of stout planks, which could only be opened when a drawbridge was lowered. The drawbridge partially spanned the ditch in front of the ramparts and rested on a fixed bridge that completed the span, giving onto a *place d'armes* on the covered way and an outer gate in the passageway through the glacis.

In front of the King's Bastion the ditch was dry, but in front of the Dauphin Bastion the low terrain inevitably resulted in a wet ditch once the fortifications had been laid out and the ditch dug. The large natural pond between the hillocks on which the bastions were set was thus connected directly to the harbour and sealed off from the town by the Dauphin ramparts and, later, the curtain leading to the King's Bastion. The flow of water between pond, ditch and harbour could be controlled by a sluice-gate set in a small dam *(batardeau)* which closed off the end of the ditch. It was apparently intended to raise the level of water in the ditch by closing the sluice and letting water build up,[4] rather than opening it and letting the sea in at high tide as would be more logical today because of the rise in sea level.

In 1727 Verrier turned his attention from the King's Bastion to the harbour defences, and started to plan seriously the form the Dauphin Bastion and its battery would take. The actual work of digging and laying the foundations began the following spring; by June the foundations of the flank were nearly finished and work was proceeding along the face,[5] a substantial portion of both escarps being raised by the time winter threatened.[6] Progress seems to have been much more rapid than on the King's Bastion, with at least the left flank ramparts, including embrasures, completed by the summer of 1729[7]. By 1731 the essential work had been completed, including the buildings on the interior, the outworks and a battery to flank the quay front remaining the principle features yet to be worked on in the immediate area.[8] Not until 1735 did Verrier consider the entire bastion and related works "entierement finy";[9] this did not take into account the curtain wall connecting the King's and Dauphin bastions, which took another two years to complete.[10]

The same sort of maintenance problems occurring at the King's Bastion soon began to manifest themselves at the Dauphin. The effects of moisture penetration alternating with severe frosts first began to tell on the exposed parapets. It is clear that the remedies of clamping the embrasure stones together and applying a protective covering of turf were generally applicable to the fortifications throughout the defences.[11] Worse was to come. Difficulties in getting the lime mortar to set and provide a firm bond for the masonry revetments were particularly acute on the escarps of the Dauphin Bastion. By 1743 the left face had deteriorated badly enough to warrant special attention:

> The face of the Dauphin Bastion, from which the exterior surface was crumbling away, was also repaired, and to prevent further occurrences we judged it essential to revet it with heavy planks like those on the new fortifications; we shall use the same material in all sectors which are likely to collapse in the future.[12] (Author's translation.)

Equally serious was the bastion's value as a fortification. Built at sea level, the work was extremely vulnerable to plunging fire and enfilade. Two aspects of the terrain immediately in front of the defences were causes of concern. Occupying a large part of the low ground to the southwest was the pond which became incorporated in the ditch in front of the curtain and the bastion itself. While beneficial to the defence in that it provided an obstacle to an enemy, the pond left an extended section of the front unprotected by any outworks. The glacis in front of the King's Bastion was not developed along the entire front but stopped a short way beyond the right re-entrant *place d'armes*, to be resumed again only in front of the Dauphin Bastion, on the northern edge of the pond. Thus the escarp of the curtain was fully exposed to artillery fire and, by the same token, the right flank of the King's Bastion and the left of the Dauphin Bastion were both vulnerable.

To the north of the pond and west of the Dauphin Bastion, the ground rose again to form a series of low hillocks in a ridge around the pond. In itself, the ridge appeared innocuous. Barely perceptible from a vantage point on the hills ringing the harbour, the high points nowhere exceeded 11 m above sea level. However, it was quite enough to command the bastion from a point scarcely beyond the foot of the glacis. The ridge, moreover, was connected by further series of hummocks to the larger hills beyond. An attacking force could approach from some distance on a line oblique to the *enceinte* until practically within stone's throw of the Dauphin Bastion without ever being exposed to direct fire.

It is difficult to believe that such defects in the defence were not appreciated by the engineers, but there is little evidence of their concern. The first indication that additional defences in front of the gate were considered desirable came in 1739,[13] but Verrier did not regard the matter as pressing. Technically, he considered that a horn-work would be suitable to the local conditions, but clearly made the proposal as a gesture rather than to remedy a weakness in the defences. It was equally clear that the authorities objected to the engineer's passive resistance and besought the minister to order that the work be carried out.[14] Verrier, however, was not about to be rushed into anything. Ruminating for several years, he finally pronounced against a horn-work, rationalizing that it would take up too much space, thereby necessitating the costly effort of razing the hummock in front of the bastion, and would in any case require far too many troops if it were to be manned properly:

> If after all it is agreed to protect this gate, a counterguard will suffice in order not to extend the defences too far into the countryside, and the alignment of the right flank of the King's Bastion will allow artillery to fire on an enemy trench dug as part of an attack against this work [the counterguard][15] (author's translation)

was his sanguine conclusion. But the construction season went by without anything being done. His last words on the matter before the siege were condescending and showed an obvious reluctance to build something he felt was not required:

> To rid [the governor] of his fear, I have calculated that by extending the ditch parallel to the face of the Dauphin Bastion as far as the sea, the amount of earth which will be left in front of the gate will act as a sort of lunette ... which will double the fire-power capable of sweeping the covered way, and the flank of the King's Bastion will command the ditch and the glacis of the new work entirely, this flank being more than 20 *pieds* higher.... However, I shall begin nothing until I have received your orders.[16] (Author's translation.)

The issue then became academic. Starting from the Royal Battery and working their way systematically around the harbour, the New England forces pounded the tenaille front the Circular Battery into total ruin. At the same time, siege batteries were established in the hills overlooking the town and moved forward to the broken ground in front of the Dauphin Bastion, their final position being the hillock that was of such sublime unconcern to Verrier. Concentrating their efforts in this area, the New Englanders opened a breach large enough to convince the French of the futility of further resistance.[17]

> The weakest part of the Fortification of this Town is the Rentrant Angle of the Point of Bastion Dauphin ... this part cannot be made stronger but by pulling it quite down and Erecting a New Work of a Better design, for which Plans and Estimates must be sent home and approved. In the meantime raising a Cavalier for 5 or 6 guns ... repairing the Platforms and Parrapetts are works absolutely necessary to be done.[18]

Thus did the governor of the newly acquired British possession and his chief engineer evaluate the entrance to the town and the means to improve it. The cavalier was built, largely from the rubble of the Circular Battery, so that more powerful artillery fire, in an elevated position, could counteract the menace of the nearby commanding ground, but the more ambitious plans were never carried out. In the face of possible attempts by the French to recapture the town, only temporary repairs were made and when the place reverted to its original owners by virtue of negotiation, much remained to be done.[19]

Upon his return, Boucher stoically set about inspecting the fortifications and preparing estimates of the work needed to return them to the state they had been in before the siege.[20] It is not known exactly what his instructions were and to what extent he was free to modify the earlier concepts, although it seems likely that he was required not to contemplate radical changes and great expense. His proposals for the Dauphin Bastion were essentially intended to restore the entire work to its original form, including the Circular Battery.

It was not until Franquet's arrival in 1750 that a serious analysis of the fortifications was authorized or various means of improving the defences given full consideration.[21] Judging the front between the King's and Dauphin bastions as one of the three worst fronts[22] and one that required much careful study before he could determine how to improve the situation, the engineer stressed the weakness of the low curtain with nothing but the pond in front of it and the obvious dangers from the nearby heights. His various proposals all included additional works in these crucial areas.[23] The minister's blunt refusal to approve the additional works, ruling that "le grand project de fortifications est entierrement impraticable,"[24] must have dampened Franquet's enthusiasm.

Repairs and improvements to the existing works were authorized, as was Franquet's proposal to retain and strengthen the English cavalier. Behind the gate, the guardhouses were eliminated and the ramparts thickened. Construction of additional works was limited to spanning the pond with a simplified tenaille, which joined the two separate sections of the covered way in front of the curtain into one continuous work, flanked by the existing *place d'armes* near each junction (Fig. 97). Of the elaborate works proposed in front of the gate, the need for which had been more than justified by the events of the first siege, nothing was done. All Franquet could do in the area was to lower the tops of two of the highest hillocks by 7 or 8 *pieds*.[25]

Such measures were not enough. Benefiting from detailed knowledge of the ground acquired by the British occupying forces after the 1745 siege, Wolfe in 1758 made directly for the "two Eminences not far from the West Gate,"[26] from which vantage point a battery of guns and mortars wrought heavy damage on the whole town. Naturally enough, the Dauphin Bastion, being the part of the defences closest to the attacks, suffered the worst. The cavalier was immediately transformed to rubble, to the malicious glee of the young brigadier.

> You know I hold Mr. Knowles in the utmost contempt as an officer, and an engineer and a citizen. He built a useless cavalier upon the Dauphin Bastion which fell to my share to demolish, and we did it effectively in a few hours.[27]

Franquet's work on the cavalier seems to have been ignored; in any event, it had done little to improve its resistance to artillery fire at close range.

The totally ruinous state of the bastion, in which only the left flank could still be considered defensible, caused the French to contemplate surrender, and when a breach 28 *toises* wide had been opened, the governor ordered the garrison to capitulate.[28] Along with the rest of the defences, the Dauphin Bastion was given the *coup de grâce* in 1760 with the springing of demolition mines within the remains of its ramparts, postern tunnel, and even the gate (Fig. 102).

Examination of the site prior to excavation did little to encourage the belief that any useful information, beyond perhaps the outline of the wall foundations, lay beneath the low grassy knoll pockmarked with demolition craters. Unlike the citadel, the Dauphin Bastion had contained no massive masonry structures in its ramparts beyond the escarps themselves and hence no surviving features could provide a reliable datum. The alignment of the left flank and face could be only approximately determined from the irregular line of rubble partially submerged by the waters of the pond which, no longer having a clear channel to the sea, must have risen considerably since the 18th century. Occupation subsequent to the final abandonment by the British in 1768 had also left its mark. Early 20th-century photographs showed houses within the bastion, and rectangular depressions, clearly not demolition craters, to be the foundations of four late 19th- or early 20th-century houses.

Although they had made no attempt to expose and stabilize the Dauphin ruins, the restorers of the 1930s had still disturbed the bastion by their desire to improve access to the site. From the present-day town of Louisbourg, a road followed the shoreline around the harbour, entering the fortress at the Dauphin Bastion, and led to the 1930 museum building. Within the old town, they attempted to align the road on the French street system, following the Rue de Quai and Rue St. Louis to a parking space on the parade square below the townside glacis. Whether or not in selecting this route they had realized that significant remains might have been encountered as the road crossed the ditch and joined the Rue de Quai, no attempt was made to preserve, stabilize or record anything found en route. The roadway had been bulldozed level, the unstable remains of the rubble thus exposed had been revetted with a stone wall, and a cairn of dressed stones had been set at the approximate site of the original Dauphin Gate. Moreover, free use had been made of the rampart material from within the bastion and from the nearby curtain wall as roadbedding.

Natural causes also were taking their toll of the site. The shoreline, retained by heavy openwork timber cribbing built in the 20th century, no longer closely resembled that shown on the 18th-century plans but was much more heavily indented, indicating considerable erosion, as did disintegrated rubble masonry, water-smoothed bricks and crumbling sandstone on the beach in front of the bastion.[29]

Archaeology: The Research Strategy

The ruined state of the work and its low-lying situation, much of it below water table, dictated the archaeological approach. The site was excavated over a two-year period; like the original builders, the archaeological forces went into the field as soon as the ground was sufficiently thawed in the spring (mid to late May) and stayed until the onset of winter (mid to late November). Initially trenches were laid out as close to 90 degrees to the alignment of the ramparts as could be estimated from the existing contours, and dug by hand in an attempt to locate any surviving portions of the escarps as definite orientation for the rest of the excavation, but in all cases the level of the pond was reached before any intact sections of masonry were encountered. All that was exposed was unstable rubble and earth fill. Flooding and trench collapse effectively precluded further excavation without a change in method.

There are, undeniably, serious drawbacks to carrying out archaeological excavations within the framework of what is essentially a construction programme. On the other hand, one of the great benefits is ready access to a wide range of sophisticated equipment. Inasmuch as the working conditions of the archaeologist will sooner or later become those of the construction crews, with a certain degree of planning and co-ordination, work can facilitate the former's task and, with little extra effort, also meet the latter's needs. It was so with the Dauphin Bastion and, eventually, the whole historic waterfront.

The original builders had not helped matters by incorporating the pre-existing pond into their wet ditch, making use of naturally marshy ground wherever possible. It would nevertheless appear from the profiles on the 1727 proposals (Fig. 160) that considerable excavation was required before the ditch completely cut off the bastion from the country. An ideal catch basin was thus formed into which all groundwater flowed from the hillside on which the King's Bastion stood, bringing with it mud and silt from the entire front. With the collapse of the ramparts into the ditch, drainage was impeded and the pond continued to widen. With the gradual rise of sea level, any natural drainage through the channel was reversed.

As a first step in solving the problem, two 6-inch pumps lowered the water level of the pond until an equilibrium could be maintained by running a trash pump 24 hours a day. The pond was still far from dry. A thick residue of oozing, foul-smelling mud remained, in places as much as 2-4 m deep, too viscous to be pumped, yet too liquid to be excavated by normal means (Fig. 170). A pad was therefore built in the pond by dumping earth in a line roughly parallel to the ramparts until its surface was above the surrounding quagmire. The pad was wide enough to support a 35-ton caterpillar-mounted power shovel which scooped out the sludge and collapsed rubble on the bottom of the pond until the intact base of the escarps was reached. The material was removed by 3-ton dump trucks which were reversed along the pad behind the shovel. The ensuing trench, 1.5 m below present sea level, formed a sump into which the rest of the swamp gradually drained; constant pumping kept it relatively free of water. Eventually the mud dried sufficiently to enable one to walk on it. Six baulks were left to establish sections across the escarps and ditch to the outworks, which could be examined as the area gradually became consolidated. It made little sense to continue the trench to the shore, since every high tide would then have inundated it. In anticipation of eventual excavation in the *batardeau* and Dauphin Gate area, earth fill was dumped at low tide to form a dyke around the end of the quay. A culvert built beneath the 1930s road had never functioned properly, but was opened and the newly operational ditch connected to it. Water from the pond now flowed into a lagoon between the dyke and the sea, from which it could be pumped with the 6-inch pumps. The former road was closed and all traffic into the park routed around the dyke. So successful did this operation prove that the dyke was eventually extended along the entire length of the quay, enabling research and construction work to proceed in that area also.

The clearing of the ditch was not the only operation in which heavy equipment was used. With the installation of the dyke route, the tarmacadam surface of the 1930s road and its crushed-rock bedding could now be rapidly and neatly removed with the power shovel. Eventually a trench 21.5 m long and a maximum of 5.2 m deep was excavated across the rampart to establish a cross-section through the face and the cavalier. Such a trench would have occupied the whole crew for the entire two seasons had it been attempted manually. A small tractor with a hydraulic boom and shovel was used for trenching across the terreplein of the bastion, opening exploratory trenches to locate the foundations of the Circular Battery, trenching the glacis, and removing quantities of rubble.

Although far more widespread these days, the use of mechanized equipment is still a controversial issue and no hard and fast rules can govern its use. In each case, the archaeologist's judgement is crucial to the successful outcome of the operation, and he alone must bear the responsibility for lost or damaged evidence. But he is equally responsible for the wise and efficient use of his manpower and of an excavation budget: too much time ill-spent can also result in evidence being lost. Crew safety must similarly loom large in any operation. In spite of the depths of trenches with sides of unstable rubble, no injuries were sustained due to cave-ins, and the only victim of the quagmire in front of the walls was the author's boot. In areas where mechanical equipment was manifestly not desirable, the more conventional methods of excavation prevailed. A judicious combination on mechanical and manual excavation yielded a quantity of information that came as a pleasant surprise after the initial appraisal of the terrain.

Ramparts: Escarps

In the initial, manually excavated trenches perpendicular to the alignment of the left flank, considerable quantities of collapsed rubble masonry were interspersed with modern intrusions -- garbage pits, latrines and an ice-house. No coherent remains of the escarp were encountered at this stage, excavation being halted at the water table. Subsequent to excavation by mechanical means below this level, the surviving wall base, badly damaged and distorted even at that depth, was revealed. Evidence pertaining to the escarp's original construction and later repairs was forthcoming. In one section, the wall facing consisted of several reused dressed stones and roughly faced fieldstone, which contrasted with the random-coursed rubble masonry elsewhere (Fig. 178). Large timber uprights, approximately 13 cm x 20 cm square, were also present. At the re-entrant angle between the flank and the curtain, the repairs had consisted of a secondary facing laid over the original, thickening the escarp of the flank by some 60 cm in the process and covering part of the curtain-wall facing and encroaching upon the entrance to the postern tunnel in the curtain. At the other extremity of the flank, the bottom course of dressed stone quoins forming the original shoulder angle were located (Fig. 179). Thus the exact length and alignment of the flank could be measured and the alignment of the face deduced from the angle to which the stones had been cut. This in turn permitted the location of the flanked angle to be calculated within narrow limits, and ensured that mechanical excavation could continue without risking the destruction of what remained of the face.

Unlike the left flank, the left face escarp exhibited no trace of an added outer facing, although traces of planking adjacent to, but not overlapping, the shoulder angle quoins were found. Indications of repair work were observed in the loose rubble that had sunk to the bottom of the ditch. Near the shoulder angle were found dressed stones that bore a different cutting pattern from that normally observed on the original stones located throughout the site: broad, parallel grooves as opposed to the rough, pointed or bush-hammer finish so characteristic of the French stonecutters. The faces of the stones were cut to a batter of one in nine. Square timbers similar to those found on the flank were present, together with Z-shaped wrought-iron rods approximately 1.5 m long; direct parallels later found *in situ* on the quay wall demonstrated that the rods were set horizontally in the wall, one arm anchored firmly in the core of the masonry, the other hooked around the timber upright to retain it against the face of the wall.

Finally, at the flanked angle came evidence of two distinct construction phases. Surviving to a height of four courses was the original angle, the quoins of which -- all finished in the recognizably typical style of French workmanship throughout Louisbourg -- were dressed to a batter of one in six and formed angle of 82 degrees 30 minutes; however, in the ditch in front of the flanked angle were quoins cut to an angle of 80 degrees and with a batter of one in nine, like the stones near the shoulder, and similarly exhibiting different cutting patterns from the *in situ* stones.

To the right of the flanked angle, the tenaille extended as far as the sea wall. The escarp had been almost totally destroyed, with only the very lowest courses, deep in the silt of the ditch, surviving intact and everywhere surmounted by unstable rubble and loose rampart fill. Within the core of the wall were numerous bricks and dressed stones which had clearly been intended for functions other than rubble fill, and hence indicated that substantial rebuilding had taken place.

The archaeological evidence for the escarps suggests major repairs to the original walls, followed by almost total destruction. Only by reference to documentary sources does the extent of the various repairs become apparent. Even before siege damage necessitated such work, the walls were seriously in need of maintenance. By 1743 it is likely that at least the left face had been encased in planking, a technique becoming general at Louisbourg and apparently chosen as the original method of constructing the quay wall. The planking near the shoulder angle and the timber uprights with wrought-iron anchors in front of the left face could therefore date to the repair phase prior to the first siege; however, the added facing on the left flank was more in keeping with a rebuilding and may be attributed to the New England forces:

> The South Flank of this Bastion, the Merlons and Embrazures being entirely ruinous, they have been taken down and Rebuilt with more thickness and a greater Talus from the foundation to the Cordon.[30]

The dressed stones in the areas of the flanked and shoulder angles raise a problem of conflicting evidence. The unusual cutting pattern was observed only on dressed stones found in the Dauphin Bastion area; all other dressed stones at Louisbourg have an equally distinctive but very different finish which, because of the contexts, can be attributed to French craftsmen. Late 18th- and early 19th-century stone structures elsewhere in the province exhibit the broad parallel grooves,[31] permitting the conclusion that such a style is characteristic of British craftsmen. From the accounts of the British occupation, the Dauphin Bastion appears to have received the most attention, but the only reference to "free-stone facing" (i.e. dressed stone) concerns the *batardeau* across the ditch in front of the Dauphin Gate which was in such poor condition that it had to be taken down and rebuilt, although the work was unfinished.[32] As exposed during excavation, the seaward façade of the *batardeau* comprised mostly "free-stone" finished with parallel grooves. The attribution of the later shoulder and flanked angles to the New England period therefore seems well established; however, the batter to which the stones were cut does not harmonize with Bastide's "greater Talus." By itself the phrase could refer to a steeper, more nearly vertical slope, but in conjunction with Bastide's earlier general criticism, such an interpretation scarcely seems appropriate: the walls, he had noted, were "too upright everywhere to support the weight of the Rampart."[33] To attempt to reconcile the conflicting evidence would be to indulge in fruitless speculation.

Ramparts: Terreplein and Interior Slope

The escarps were designed to retain the mass of the rampart on the side facing the country; on the inside of the bastion, the rampart was stabilized with sloped earth. In spite of the disturbed nature of the site as a whole and perhaps because an earth embankment is more resistant to total collapse than a masonry wall, some evidence pertaining to both the rampart terreplein and the interior slope was detected in section. As the highest surviving point on the left flank was near the shoulder angle, a trench was dug through the rampart there at 90 degrees to the escarp. Trenching across the highest part of the rampart revealed strata that was apparently the original surface of the rampart terreplein (Fig. 172). These layers had survived only in this spot, possibly preserved by the superimposition of a traverse flung up during the second siege.[34]

Evidence substantiating the conclusion that this was the terreplein level came from the excavations of the right face and associated buildings. Being incorporated in the rampart slope, the rear walls of the two buildings identified historically as a barracks and powder magazine had been well preserved. The powder magazine wall was virtually intact to eave level and the elevation of the eaves could thus be established with certainty at 5.79 m above sea level. The rampart, being laid directly against the rear wall, could not have been higher than the eaves; on the historical profile through one of the buildings, the roof is depicted as standing proud of the rampart terreplein (Figs. 161, 162). The lower limit of the rampart elevation was derived from a makeshift masonry repair grafted onto the northwest corner and west wall of the magazine. The base of the repair work was on a horizontal surface to the rear of the building, but on a sloping surface along the west wall. It was therefore concluded that the repairs had been laid directly on the rampart terreplein and interior slope. The base of the repair work on the rear wall was at an elevation of 5.66 m, which proved to be the elevation of the left flank rampart level.

As with the King's Bastion, the assumption was made that the flank and face were built to the same elevation, with no slope or sudden change in level, and the archaeological evidence supports such a contention. Franquet's report makes specific allusion to the relationship, but also introduces a measure of uncertainty:

> The left flank of the Dauphin Bastion, 4 *pieds* higher than the curtain, is level.... The left face of this bastion is at the same level as the flank for 3/4 of its length, and further along is a rise of 2 *pieds*, extending to the flanked angle, which is therefore 26 *pieds* lower than the [flanked] angle of the King's Bastion.[35] (Author's translation.)

All the evidence agrees that the face and flank were at the same level.

What is the 2-*pied* step-up towards the flanked angle? There is no indication that any raising of the work was intended or carried out by Verrier; on the other hand, a barbette platform had always been included in the project. By the time Franquet's earliest plans were drawn in 1751, embrasures are depicted along the left face and through the parapet in front of the barbette (Fig. 87). He proposed suppressing both the barbette and its embrasures in his first project of the same year (Fig. 88); however, by 1756 the barbette is still shown, although with some embrasures blocked (Fig. 97). The presence of embrasures in front of the barbette, which was by definition designed to permit cannon to fire over the parapet, requires explanation. We must assume that the parapet had been raised to such a height as to require embrasures, probably to protect the defenders from the approaching siege batteries, and that the New Englanders had retained the modification. It must have been this work that Franquet noted without further comment.

An equally satisfactory explanation for the difference in elevation between the two bastions, as recorded by Franquet, cannot be brought forth. Subtracting 28 *pieds* (allowing 2 *pieds* for the barbette) from the deduced elevation of the magistral line at the King's Bastion, the rampart terreplein elevation of the flank and face of the Dauphin Bastion would have to be almost a metre higher than the archaeologically derived figure: 6.6 m as opposed to 5.66 m. Conversely, the 28 *pieds* added to the elevation of 5.66 m would indicate that the King's Bastion elevation was only 14.76 m instead of 15.70 m. While there is margin for error in the deduced elevations, it is clear that the top of the casemate arches acted as a limiting factor below which the rampart terreplein of the King's Bastion could not have been constructed; the eaves of the Dauphin powder magazine, conversely, act as a limiting factor above which the rampart terreplein could not have been raised. Franquet's measurements cannot be made to conform even within these limits. It is possible that the engineer was taking his measurements not from the magistral line but from the terrepleins of the ramparts as they had been modified by the occupying forces, but this hypothesis cannot be tested.

Whatever the demerits of the location chosen for the Dauphin Bastion, the builders had at least tried to make the best use of the little high ground available in the immediate vicinity. The work was set on a low knoll, the highest point of which was between the powder magazine and the flanked angle. Natural soil horizons indicated a steady rise in original ground level from the shoreline and from the marshy borders of the pond to the south and southeast. The distinctive orange, iron-enriched B horizon observed in front of the powder magazine was some 60 cm higher there than at the south end of the barracks. Further to the north, only unweathered parent material (C horizon) could be detected beneath the cavalier (Fig. 174). In other words, the ground had continued to rise, but the upper, weathered horizons had been removed in order to provide sufficient height to the ramparts from within the bastion. Obviously it made no sense to remove natural hillside only to build up an earthen rampart, and natural surface was again encountered beneath the rampart slope at 4.7 m above sea level: this must have been close to the highest point of the hill prior to construction. On the covered way of the glacis, natural horizons were at slightly lower levels. The extent to which the intervening ground had been at a similar level or descended into a natural gully cannot be ascertained since the whole area had been transformed into the ditch; however, the Verrier's 1727 profile indicates an undulating terrain with a dip where the ditch was to go (Fig. 160).

The nature of the ground permitted the builders to set foundations on the original surface in certain instances. Excavations on the left face exposed some surviving sections of a wall slightly less than 1 m thick, parallel to and approximately 6 m behind the escarp. This was manifestly the interior revetment of the parapet. No obvious indication of a batter was observed. The base of the revetment was uniformly low, located on natural soil except at the flanked angle, where in spite of being at its lowest point (3.7 m ASL), it had not attained the old ground surface, but was suspended in rampart fill. Clearly, the hillside had begun to drop too steeply for the builders to continue laying the wall on the original contour.

At the same location, the alignment of the revetment changed, turning towards the flanked angle. The extremity of the parapet was thus delineated. Judging from the various historical plans, a *guérite* was located at the angle, access to which was by a passageway much like the one at the King's Bastion. If such were indeed the case, then the section turning towards the flanked angle would have terminated the left face parapet at the same time as it served as one wall of the passageway to the *guérite*. No trace of its counterpart to the right of the flanked angle could be located: the area was too disturbed.

The condition of the entire front from the flanked angle to the quay wall was such that little information of any value to an understanding of the defences or the sequence of events could be derived from the archaeological investigations. Above the foundations of the escarp, unstable masses of rubble with no coherent pattern were encountered. The only feature that retained any form consisted of bricks and dressed stone in a pattern which permitted its tentative identification as a embrasure, but its relationship to the rest of the ramparts could not be determined. The clearest picture of what must have existed is obtained from the historical plans.

The short section of rampart from the flanked angle to the change in alignment bringing it perpendicular to the quay would have been a foreshortened right face (Figs. 161, 163). The plan of the town drawn by Verrier *fils* in 1745 to indicate the progress of the siege indicates two embrasures on this face, presumably the "deux embrasures de la barbette" Boucher referred to in his initial tour of inspection.[36] If they were related to the barbette, they were likely to have been embrasures built up with gabions or fascines on top of the parapet, rather than through it. The New England forces appear to have retained the barbette embrasures while raising the cavalier on the terreplein to the rear; the condition in which the works were left at the time the fortress was returned to the French is presumably reflected in Franquet's plan of the front of the "Ancienne fortification" drawn in 1751 (Fig. 87). What modifications occurred thereafter cannot be known in detail. It is not possible to determine which of Franquet's various proposals were in fact carried out, while the total ruin of the cavalier and parapets during the second siege, followed by the demolition of what remained of the ramparts, effectively frustrated archaeological attempts to achieve greater precision.

Ramparts: Circular Battery

From the outset, the concept of a battery complementing the harbour defences had been envisaged at the point where the landward fortifications joined the shoreline, and by 1723 Verville's plans reflected in all major essentials the work Verrier later carried out. Designed neither to flank nor to be flanked by other works, the battery did not conform to the bastioned trace that determined the layout of the *enceinte*. Its inclusion within the Dauphin Bastion was therefore a matter of convenience and economy rather than of strict military necessity. Perhaps the greatest benefit from the interrelationship was that of mutual protection: the rear of the battery was screened from reverse fire by the ramparts of the bastion, while it in turn closed off what would have otherwise been the exposed interior of the bastion. As a single unit, the design facilitated communications: troops and even artillery could readily be moved from one rampart to another without leaving the confines of the bastion. Conversely, the very proximity of the battery to the other ramparts created a hazard: the combined works presented a single target sufficiently large that a shot would be bound to strike somewhere. It is doubtful that the walls offered much protection against any but nearly horizontal trajectories; because of its location, the bastion was vulnerable to ricochet fire and shot following curved trajectories from elevated guns or mortars. The Circular Battery was so badly damaged during the first siege that the occupying forces saw no point in attempting to repair it. Franquet, too, judged the value of the battery insufficient to warrant rebuilding it, and retained the concept of a cavalier as introduced by the English.

The immediate archaeological objective was to locate any elements of the battery that might have survived and to establish more precisely its relationship to the bastion. Five ft.-wide test trenches were laid out to intersect the projected alignment of the battery based on historical plans and the previously established location of the left flank and curtain. Sufficient traces of masonry were encountered to enable the entire alignment of the escarp foundations to be established with some accuracy; however, a large section in the middle was devoid of any structural remains. As the ground here was lower than the surrounding areas prior to excavation and as no weathered soil horizons were present, it was concluded that large amounts of earth and rubble had been removed. The most likely activity to have accounted for such large-scale earth moving was the road-building operation of the 1930s.

The thickness of the escarp foundation was not uniform, varying from a minimum of 2.59 m to a maximum of 3.73 m. The range is explained in part by disturbance, even at foundation level, during the dismantling of the badly damaged wall, and in part by the fact that the foundations were built as an enlarged base wider in some sectors than in others according to the bearing capacity of the subsoil. At the northern end of the battery, where the escarp had survived to its greatest height, the wall on top of the foundations was 2.94 m thick. From this we may deduce that an original thickness of 9 *pieds* (2.92 m) had been intended. In his estimates of material needed to reconstruct the battery, Boucher calculated an average thickness of 8 *pieds*;[37] as this was an average for a wall built to a batter and no separate calculation was made for the parapet, there is no inconsistency.

More contentious is the issue of the rampart behind the escarp. On the earlier historical plans, the rampart is generally depicted as backed by an interior slope of earth, as were the left flank and face ramparts, but the later plans indicate a masonry revetment except one plan, presumably by Verrier. Unfortunately undated, it is specifically of the "Demy Bastion Dauphin ... avec sa Batterie de 16 canons," does not appear to be simply a work proposal, and shows the rear of the battery with an interior slope (Fig. 162). Absent from the plan is any conceptualization of the small battery or *éperon* later built to flank the quay. When Verrier informed the minister at the end of 1730 that the Circular Battery was completed, he also noted that the *éperon* was yet to be undertaken.[38] The first proposal for the *éperon* was shown on a plan indicating work to be done in 1731 and therefore presumably drawn in 1730 (Fig. 163). Verrier's undated plan could thus be dated to about the same time, and is the last plan to indicate an interior slope as opposed to a masonry revetment. Faced with consistent indications of a revetment thereafter, one would have expected to uncover its foundations in the course of excavation, but no trace was found. Boucher in 1749 prepared estimates for the rebuilding of the Circular Battery, but the masonry figures he gave were only enough to account for the escarp and parapet.[39] Had the wall survived in good condition, he would not have needed to rebuild it, but this seems unlikely: the New England forces had no use for the Circular Battery and would hardly have left its ruins across the interior of the bastion even if they had not used the collapsed material to build their cavalier. The remaining possibilities are that Boucher was calculating just for the escarp and did not consider rebuilding the interior revetment, or that it had never been built in the first place. Significantly, in the 1730 plan and profile (Fig. 163) the masonry revetment is colour coded as part of the work to be completed the following year in spite of Verrier's statement that the work had been finished by 1730. It is not impossible that on a site as disturbed as the Dauphin Bastion, an entire wall could have vanished without trace. The Circular Battery had, after all, been demolished and never replaced. Little enough remained of its more substantial escarp, and on the historical profiles the interior revetment is not as deep as the escarp foundations. On the other hand, interior revetments elsewhere, whether of parapets or of ramparts, had been found, extending in all cases several feet below the surface. Both a slope and a revetment had been envisaged by the designer: neither was inherently more sound that the other. A revetment would have taken up less space on the interior of the bastion, but as the battery was a relatively low work, the additional space taken up by a slope would not have been a great inconvenience. The conflict of evidence [illegible] remain.

As the battery closed the rear of the bastion, a means of access to the interior had to be provided. Although showing differences in detail, all plans consistently indicate an entranceway near the junction of the battery with the left flank. It therefore was no surprise when the foundations of the feature were encountered there, nor was it a surprise that virtually nothing had survived above what would have been the working surface of the post-1745 bastion. From the admittedly imprecise technique of scaling the measurements, the passage through the escarp was expected to be at least 1 *toise* (1.95 m) wide. As depicted in elevation (Figs. 161, 162), the opening was a substantial archway of dressed stone surmounted by a plaque, presumably bearing a royal crest, to form an entrance suitable both stylistically and functionally to its situation as the sole means of communication to an enclosed bastion. Yet the archaeological evidence pointed to an opening through the escarp of little more than half the expected width. A 6-*pied*-wide opening had been partially blocked and a much narrower doorway, only 1.0 m wide, built within a deep recess. The narrow doorway was offset, one side making use of the original opening (Figs. 180, 181). The masonry-walled passage was defined by the ramparts of the left flank to the south and those of the Circular Battery to the north. Immediately behind the escarp its walls were very close to the 6-*pied* width of the original opening, but diverged slightly toward the interior of the bastion.

Excavation outside the entrance revealed the presence of a feature the existence of which had appeared dubious on the basis of historical analysis. Shown on earlier plans is a short, curving wall in front of the entrance (Figs. 160-163). The wall does not appear on later plans, implying that it was an early proposal which had never actually been carried out,[40] but as the archaeological investigation demonstrated, the outer wall had indeed been built. What was its function and why was it not indicated on plans after the mid-1730s? Early elevations clearly show the entrance through the Circular Battery rising above the outer wall, which appears to diminish in height as it approaches the shoreline, so no defensive, screening function could have been intended. As the bastion was located on a low knoll, with the ground rising up from the shore and townside to a high point somewhat behind the flanked angle, the entrance in the Circular Battery was at one of the lowest elevations. On the townside the ground continued to drop into a low, swampy area generally depicted on early plans as totally inundated. The low, curving wall may thus be explained as a protection against flooding; by providing a ramp up from the beach, the builders assured themselves of a dry, firm roadway wide enough to permit easy access.

Terminating in a short section of wall perpendicular to the escarp and just beyond the entrance to the Circular Battery, the ramp effectively funnelled approaching traffic in only one possible direction -- into the bastion. Anyone wishing to enter the bastion had to follow this route or else wade through mud and water and clamber over the ramp retaining wall if he wished to take a short-cut. Such an arrangement might have been acceptable to begin with, but by the mid-1730s, other projects were radically altering the landscape and the communication requirements. The curtain wall connecting the King's and Dauphin bastions was constructed across the pond; water was channelled through the ditch of the Dauphin Bastion and out through the sluice-gate in front of the defences, not between the bastion and the town as before. The small segment of the pond sealed behind the walls was thus no longer fed by the rivulet and the groundwater from the King's Bastion, and could well have begun to dry up of its own accord, although undoubtedly fill was added to encourage the process. At the same time, the addition of the curtain meant that the Dauphin Bastion was no longer an isolated work but part of an integrated defensive system. Movement of troops would tend to be peripheral, along the curtain to or from the main area in the King's Bastion, or radial, through the ramparts to the outworks on the far side of the ditch. To allow this, a sally-port or postern tunnel was included in each end of the curtain. Because direct access then had to be provided from the Dauphin Bastion to the adjacent postern, the retaining walls of the ramp were probably taken down to such a level as permitted the free circulation of troops from one area to another, a level which would in part have been determined by the level of the postern floor.

Although the condition of the surviving masonry in the re-entrant area as a whole was so poor as to preclude any detection of construction sequences beyond those already noted for the left flank escarp, the work of joining curtain to escarp and of incorporating the postern tunnel probably required such extensive modifications to this sector that everything south of the entrance to the Circular Battery was taken down and rebuilt. By this time, the construction within the bastion had been completed and the majority of its cannon already installed,[41] so an entrance as wide as originally designed may have been considered no longer necessary and a narrower version incorporated in the modifications.

Whether it had been reduced in width or was originally very narrow, the entrance must have taken on the aspect of a tunnel as it passed through the escarp. If any credence is placed in the plans, the parapet of the Circular Battery continued over the passageway. The symbol representing a vaulted roof appears on one plan (Fig. 161), and a vault would have been the most logical way of spanning the gap. A few traces of brick fragments found in the passage suggest that the arch may have been at least lined with brick if not entirely formed with this material.

On the other side of the passage, the northern retaining wall would have held back the fill of the Circular Battery rampart, its height and shape confirming to the profile of the rampart. If the latter had been built with an interior revetment, the retaining wall would have been of a uniform height; if the rampart was stabilized by a slope, the retaining wall would presumably have reflected this, gradually decreasing in height towards the interior of the bastion. It would also have been somewhat longer, but the full length of the wall had not survived, thereby frustrating any hope of resolving the issue. On the basis of evidence derived from the northern extremity of the Circular Battery, the terreplein of the rampart -- and hence the maximum height of the wall -- was some 2.53 m above the surface of the passage.

The design of the entrance through the Circular Battery left something to be desired in practical terms. If the intent was to form one unit of battery and bastion, then leaving the passageway open behind the escarp presented a serious inconvenience. There was no direct communication from the rampart of the flank to that of the battery -- a problem above all for the effective movement of ordnance, but also of troops. In addition, the open gap would have been an hazard to safety. This could have been overcome to a certain extent by building the retaining walls of the passage higher than the adjacent terrepleins, but no evidence suggests such measures, let alone any attempts to span the gap in its entirety.

Parapets

The highest surviving point of the bastion was to the rear of the presumed gate location, overlooking the 1930s road. The configuration of the ground there was attributed to the presence of the cavalier, the fill of which, having been raised in part on the earlier ramparts, would have formed a large mass of earth considerably higher than the adjacent features.

Excavation proved the bulk of the material to have indeed belonged to the cavalier, but the most informative features were only indirectly associated with that structure. Where the 1930s road had been cut through the ruined ramparts, an unstable embankment of rubble, retained at the base by a masonry wall, had been left exposed. In a trench perpendicular to the embankment on the more stable side, on the interior of the bastion, the remains of a wall were soon encountered and, within it, the remains of the rear of two gun embrasures (Figs. 182, 183). Franquet's plans showing the cavalier in some detail suggested that the two embrasures in the end wall overlooking the harbour had been located, but this interpretation was unsatisfactory. In the first place, the embrasures had been blocked with masonry and some of the dressed stone was missing although the rubble wall was reasonably intact.

Secondly, the soles of the embrasures were far too low to have belonged to the cavalier, which was constructed to have great command over the country and hence was raised above the terreplein of the original ramparts by some 8 *pieds*.[42] The soles of the embrasures were far from horizontal in their excavated state, but elevations taken at the least disturbed area indicated an original elevation of 5.95 m above sea level. The level of the platform beneath the embrasures on which the guns were located would have to have been at least 2 *pieds* lower than the soles, but the rampart terreplein elsewhere had been established at 5.64 m above sea level. The embrasures were clearly not functional elements of the cavalier.

Further trenching demonstrated that the newly discovered wall was on the projected curve of the Circular Battery escarp. The similarity of construction techniques and materials between the wall, with its gun embrasures, and other features of original construction were much greater than between the recent discovery and construction known to have been carried out by the New England forces or by French workers under Franquet's direction. Contrary to all expectation, a substantial portion of the Circular Battery had survived.

In the light of this information, the way in which the north end of the cavalier had been finished could be understood. As the Circular Battery curved towards the Dauphin Gate, its escarp ran parallel to the quay and separated the bastion from the main road into the town. At least the rear of this section of wall had not been demolished. Instead, the occupying forces had incorporated it into their revised design for the bastion. There was no need to build a massive retaining wall for the end of the cavalier overlooking the harbour when one already existed; all that was needed was to block the embrasures and bring the wall up to the desired height.

If the cavalier had simply been deposited on the surviving section of the Circular Battery, could parts of the rampart also be preserved? Another wall, parallel to the surviving section of the original escarp, was situated some 3 m to the south, further towards the interior of the bastion and cavalier than the Circular Battery wall. Farther south again, the fill of the cavalier extended down to the level of the bastion terreplein, and no traces of earlier ramparts were observed; however, in the space between the two walls were horizontal bands of clay and mortar (Fig. 173). The second wall was the retaining wall of a ramp from the interior of the bastion up to the cavalier, and the traces of mortar were associated with its construction. It would therefore be reasonable to assume that the mortar deposits had formed on the existing surface of the terreplein of the Circular Battery, and that the lower limits of the mortar indicated this surface, 5.4 m above sea level. Documentary and archaeological data supported such an elevation. All historical profiles taken across the left face and the Circular Battery indicate that the terreplein of the latter was slightly lower than the other; the archaeological evidence pointed to an elevation of circa 5.64 m for the left flank and face ramparts. As the soles of the surviving gun embrasures had been established at 5.95 m, a *genoulllière* height of roughly 0.55 m would thus exist between the sole and the postulated terreplein elevation. This, although somewhat low, would be compatible with typical *genoulllières*.

Certain conclusions as to the nature of the battery parapets could be drawn. The presence of the embrasures in the rear of the escarp confirmed the form of construction indicated in the profiles: the parapet was a vertical extension of the escarp. The parapet's width could be calculated by extending the exterior facing of the escarp, with a batter of one in six, from its base to the elevation of the rampart terreplein. The resulting measurement was 2.6 m, from which it was deduced that the parapet's original width had been 8 *pieds*, although the width as scaled from the most detailed plans is only 7 *pieds* (Fig. 167). Applying the same logic to the left flank of the bastion, a somewhat narrower parapet of only 7 *pieds* is reached. As no separate parapet revetment was found there, a similar method of construction to that of the battery seems most likely. For the left face, on the other hand, a wider parapet could be determined on the basis of the surviving revetment (see "Dauphin Half-Bastion: Ramparts: Terreplein and Interior Slope").

More precise details on the nature of the slopes and dimensions of the parapets, particularly insofar as the embrasures were concerned, came from the numerous dressed stones recovered during excavation. The majority of stones identified as embrasure components were located in the rubble fill of the cavalier; as this material was known to have come primarily from the ruins of the Circular Battery, the stones were attributed to that feature. A conjectural embrasure from the battery (assuming that all were built to the same specifications) is shown in section (Fig. 177). Similar in overall appearance to the embrasures on the flanks of the King's Bastion, those from the Dauphin battery did exhibit some differences in detail. The stones forming the coping of the merlons -- and hence the exterior crest -- were cut with a cavetto (concave quarter-round) moulding on the underside; the coping would thus have projected slightly over the vertical face of the wall beneath. The same stones revealed that the superior slope was approximately one in seven. The sole of the embrasure was somewhat steeper -- one in four -- allowing maximum depression of the guns to cover the nearby shore. With the original width at the neck of the embrasure available from the *in situ* remains, the only dimension which could not be determined directly was the height. A minimum of four courses on top of the sole stones was dictated by the surviving evidence; the possibility of a fifth was strongly suggested by the presence of an additional stone lying above the lower sole stones in the rubble fill of the embrasure nearest the Dauphin Gate. This would result in a height from sole to crest of 1.64 m, leading to the conclusion that a 5-*pied* height had been intended by the builders. The total parapet height on the interior would have been in the 7- to 7-1/2-*pied* range above the rampart terreplein as recommended by the various treatises.[43]

The number of embrasures on the battery was governed by the amount of space considered desirable between each. The spacing was flexible within certain limits, but a distance of 15-18 *pieds* centre to centre was a commonly accepted average for 9-*pied*-wide parapets.[44] On the Circular Battery the distance between the centres of the two embrasures was 5.55 m, almost exactly 17 *pieds*. The various plans do not all indicate the same number of embrasures, 16 and 17 being most frequently indicated. Seventeen *pieds* between embrasures would most comfortably accommodate 16 embrasures when adequate space at each extremity of the rampart for a gun crew to operate and traverse the gun properly is taken into account. An English prisoner held at Louisbourg noted that the battery had 16 embrasures,[45] and Boucher's estimates for rebuilding the battery[46] also mention 16 embrasures, although there are problems in accepting his calculations without reservation.

Evidence pertaining to the left flank parapet is far less satisfactory. The lack of an interior revetment and the calculated thickness of the escarp at rampart-terreplein level indicated a parapet 7 *pieds* wide, which seemed compatible with the dimensions on historical plans, but there are no profiles to give greater precision. The only specific mention of dimensions was given by Boucher in 1749 when he estimated the amount of materials required to complete the parapet left unfinished by the British: the thickness was noted as being 1 *toise* 5 *pieds* (3.57 m).[47] However, this was not the original parapet, but the one which, "being entirely Ruinous," had been "Rebuilt with more thickness."[48] While no dimensions are given, the parapet appears in the Franquet plans with a thickness compatible with Boucher's figures (Fig. 87). In the course of excavation, no trace of any parapet was detected and we must assume that the later additions were in the nature of temporary timber and earth fieldworks, rather than a masonry structure with deep foundations.

From the rubble in the ditch in front of the left flank were recovered some three dozen pieces of dressed sandstone, all identified as embrasure stones. The mud at the bottom of the pond made it impossible to observe any stratified sequence in the fill, and consequently attribution of the stones to any particular phase of construction could not be certain; however, in the short section of wall that had survived intact the repaired facing of the escarp, complete with timber bracing, included reused embrasure stones (Fig. 178). On the basis of this evidence and the assumption that the later embrasures had been constructed of different materials, it was postulated that the stones found were from the original parapet. They had several similarities with the stones attributed to the Circular Battery: the style of cutting and finish were identical and the majority had been clamped together, as the recesses cut to receive the wrought-iron clamps showed. The sole stones exhibited the same degree of slope as those from the battery, but the angle of the coping, and hence the superior slope of the parapet, was considerably steeper, akin to that observed on the coping stones from the right flank of the King's Bastion. The degree of flare at mouth and gorge was slightly less than for the battery embrasures, indicating that the flank embrasures were narrower. A conjectural reconstruction of the parapet and an embrasure, in section, is shown in Figure 172.

The least certain aspects were those of height and the number of embrasures. Assuming the left face parapet to have been built conventionally, there would have been a 3-*pied* banquette with a further height of 4-1/2 *pieds* to the superior crest. The parapet of the flank could have been brought up to the same elevation, setting the superior crest 7-1/2 *pieds* above the terreplein; however, this would produce embrasures with a greater distance from sole to superior crest than appears to have been the case. Reducing this to conform to the 5-*pied* height calculated for the battery embrasures would set the superior crest of the flank 18-20 cm lower than the ideal crest for the face.

The number of embrasures on the flank is more conjectural, varying from six to seven on the historical plans; however, the more detailed plans specifically depicting the Dauphin Bastion or the King's Dauphin front, consistently indicate seven, together with the 16 on the Circular Battery and six on the right flank of the King's Bastion (Fig. 164). It would be tempting to cite Boucher's 1749 estimates as further evidence in support of seven embrasures,[49] but his estimates must be treated with some caution: in the same memoir Boucher allowed for seven embrasures on the flanks of the King's Bastion, according to what he claimed was the original design,[50] whereas the evidence there indicated six embrasures. The left flank of the Dauphin Bastion was not appreciably longer than the complementary flank on the King's Bastion: the effective length of the rampart would have been approximately 38 m in both cases. Thus the inclusion of seven embrasures, allowing for sufficient clearance at either end, would have meant a spacing of about 4.8 m centre to centre. The equivalent of 15 *pieds*, it would have been considerably less than the 18 *pieds* normally found to be desirable, but nevertheless an acceptable minimum.

Why would Verrier have designed such a flank? The number of embrasures are in direct proportion to the amount of fire-power desired and to the concern over an adequate field of fire. The job of embrasures on the flank of a bastion was to cover the ditch and curtain between bastions, to provide flanking fire for the neighbouring bastion, and to command the outworks of that bastion. The Dauphin Bastion was ideally flanked: its line of defence -- the prolongation of the left face -- struck the re-entrant angle formed by the junction of the curtain and the right flank of the King's Bastion. Fire from the embrasures on the latter had command of the ditch between the bastions and could sweep the left face of the Dauphin Bastion with *feu razant*; likewise, the ditch in front of the face was fully exposed to beyond the flanked angle, as were the covered way and glacis.

The reverse was not true. The line of defence formed by extending the right face of the King's Bastion struck the curtain considerably short of the re-entrant angle of the Dauphin Bastion, thereby creating the technical condition of *feu fichant* insofar as flanking fire from the Dauphin towards the King's Bastion was concerned. This had been caused by locating the Dauphin Bastion as close to the shore as possible and on the best available ground in that area; the curtain, and hence the front, were thus too long to accommodate the line of defence predetermined by the number of degrees in the flanked angle of the King's Bastion. A matter of considerable dispute in the 17th century, the concept of *feu fichant* was not generally held to be desirable and was avoided in the various idealized systems attributed to Vauban. Theoretically at least, the left flank of the Dauphin Bastion could not be aligned to provide a complete field of fire: to sweep the right face of the King's Bastion adequately was a physical impossibility for a work that was some 6 m lower. The imperfect glacis, incorporating a hillock in front of the right face, compounded the problem and must have meant that the left flank of the Dauphin Bastion did not fully defend its powerful neighbour.

Could Verrier have attempted to compensate for inadequate defence with additional fire-power? In the absence of any explanation accompanying his proposals and of his calculations concerning the fields of fire he wished to establish, we shall never know. His reasoning was not shared by his successors, British or French. When the British rebuilt the flank and thickened the parapet, they installed only five embrasures. Franquet was generally critical of the parapets throughout the fortifications, finding them far too insubstantial; he was more concerned with increasing the thickness of the flank parapets than to have numerous flanking embrasures, and he kept the number of embrasures on the left flank at five (Fig. 120).

Given the complete command of the covered way and the glacis in front of the Dauphin left face from the guns mounted on the King's Bastion, there was no need to command the same ground from the parapet of the left face. Consequently, all profiles across the face consistently show the superior slope to be aligned on the covered way in the more commonly approved manner. Prolonging the slope of the glacis would not in this case have a direct bearing on the height or slope of the parapet: the prolongation would theoretically strike at or slightly above cordon level. Furthermore, according to various historical references, the glacis appears never to have been satisfactorily completed.[51] The most pertinent evidence was that of a coping stone found in the ditch in front of the left face. Like all coping stones from the original parapets in the Dauphin Bastion, the stone from the face was distinguished by a cavetto moulding, but, unlike those from the flank, exhibited a fairly modest degree of slope, indicating a parapet slope of one in seven. When prolonged, such a slope on a 7-1/2-*pied*-high parapet would strike the covered way.

There is little evidence to indicate the presence of an actual cordon. Considering the amount of stones that would have been required to provide a continuous course at the base of the parapet all around the bastion, it was only reasonable to have expected to find some during excavation, but of the more than 600 stones recovered, only one could be identified as a cordon stone and it had been incorporated in the revetment wall for the 1930s roadway near the original Dauphin Gate. Prior to the first siege the Circular Battery was usually depicted in profile as having no cordon course even though the left face in the same profiles did have one. Possibly the shortage of available sandstone -- and stone-cutters -- was even at this early date causing the builders to limit their use of this material to areas where they felt it performed a real structural function. Whatever the reason, the total absence of cordon stones from the ditch in front of both flank and face suggests that none were in position when the ramparts were demolished. Whether a cordon had been included originally is a matter of conjecture.

That a *guérite* was located at the flanked angle of the Dauphin Bastion as built by Verrier is established by various historical plans and views. In addition, Boucher specifically noted that the *guérites* of the King's and Dauphin bastions had been destroyed to their bases.[52] It appears equally certain that they were never replaced, as none are ever depicted in Franquet's plans. On this basis, the five dressed stones identifiable as forming parts of a *guérite* can be attributed to one original work. Various angles and dimensions from these stones combined with the most detailed views permitted the construction of a conjectural model conforming to the models given by various 18th-century engineers[53] (Fig. 254).

Cavalier

The most prominent feature of the bastion following the first siege was the makeshift work referred to as a cavalier and raised by the British engineers attached to the occupying forces from New England. By virtue of its prominence the cavalier was a choice target for Wolfe's gunners, and as a work grafted onto the ramparts of the original bastion with no deep foundations of its own, it fell apart under bombardment and subsequent demolition. As a result, excavation added disappointingly little to our knowledge of the structure. The front of the cavalier, in particular, had been so badly damaged as to make it impossible to distinguish between its ruins and the underlying rampart of the tenaille front. Fragments of dressed stone, brick, rubble masonry and mortar lay in a loose agglomeration that sloped down gradually towards the ditch (Fig. 184). A large part of the centre of the cavalier had been removed during fairly recent construction activity: a long section excavated across the cavalier and left face rampart revealed a deep depression, reaching almost to the natural soil horizon, which had subsequently been filled with modern refuse such as tin cans, gin bottles and tar paper (Fig. 174).

Towards the interior of the bastion, a part of the interior revetment of the cavalier was located and cleared; it proved to have been the southeastern extremity, for the masonry turned at an acute angle toward the left face of the bastion (Fig. 171). The southern limits of the cavalier, just short of the powder magazine, were thus well defined. The northern limits, overlooking the harbour, were established by a short surviving section of the original Circular Battery, parallel to which was another wall in markedly different masonry (Fig. 185). Clearly associated with the cavalier, it was interpreted as a retaining wall for a ramp leading up from the bastion interior to the cavalier ramparts; such a feature appears to be indicated on Franquet's plans (Fig. 96). Boucher's inspection report noted that the cavalier was of poor construction, being held together with plank revetting over stone fill, and he prepared estimates for installing a masonry revetment.[54] The lack of any timber remains, together with the similarities between the interior revetment of the cavalier and other walls of known French construction during the 1750s, indicate that at least this improvement was carried out.[55] Historical evidence does not point to any further modifications of any note. Franquet's various proposals were not acted upon and the work was raised only slightly in an attempt to reduce the threat posed by the low hills in front of the bastion. In this state, the cavalier supposedly stood 9 *pieds* 2 *pouces* above the parapet of the left face -- a bizarre and unrealistically accurate measurement.[56]

The impression remains of a makeshift work, never really competed to anyone's satisfaction. While Franquet's plan is probably accurate in terms of dimensions, location and detail, it conveys a greater sense of regularity and solidity than appears to have been the case.

Barracks and Powder Magazine

On the interior of the bastion were two structures readily identifiable from documentary evidence as a barracks and powder magazine. Their location and manner of construction were equally readily established by archaeological investigation. Sheltered in some measure by the mass of rampart fill piled against their west walls -- and in the case of the magazine by the solidity of its walls -- the buildings were the best-preserved features of the bastion.

The barracks was a simple rectangular building roughly 15.5 m long and 8 m wide with its long axis parallel to the left face rampart (Fig. 186). The walls, 90 cm thick, were of random-coursed rubble masonry bonded with lime mortar. At the two exposed corners facing the bastion terreplein were quoins of dressed sandstone, and two openings with surrounds of the same material were located in the terreplein wall. All these stones had been worked in the same manner: a narrow tooled margin surrounding a flat surface finished with either a bush hammer or a pointed chisel (Fig. 187). The quoins began only at terreplein level, above the enlarged footing of the wall, while at the rear of the building, where the corners were obscured by rampart fill, no such quoins had been used. Thus, although the superior joints obtained from using carefully prepared stone resulted in more solid, stable masonry and hence was a functional requirement of such features as gun embrasures, it would appear that aesthetic as well as functional considerations governed the use of materials.

Midway along the wall facing the terreplein were the remains of a doorway. From the five surviving but badly damaged sill and jamb stones it was possible to determine that a substantial door 1.07 m wide (3 *pieds* 2 *pouces*) had closed the main entrance to the building. Hinged on the left as one entered, the door would have opened inwards.

A second opening was to the right of the first, almost in the corner of the building, and was considerably different in detail (Fig. 187). It was barely 60 cm wide between the jambs, but splayed towards the interior of the building like an embrasure; the dressed stones did not extend the full thickness of the wall, but their alignment was continued in rubble stone, and a threshold of bricks occupied the thickness of the wall behind the dressed-stone sill. The most striking feature was an outer rabbet or check, half as deep as an inner one that clearly received the door. An outer rabbet would normally indicate the presence of a shutter and hence suggest that a stone bearing it had come from a window rather than a door. Apart from the fact that the feature was located at floor level, both the sandstone sill and brick threshold manifested obvious signs of wear; clearly, the opening had functioned as a doorway, not a window. Verrier's plans of the building indicate only one door but show two and, in one instance, three windows (Figs. 161, 162). In the latter instance, two windows are located to the right of the door, one being close to the corner in what would be approximately the location of the *in situ* opening. A second doorway must have been required after the initial construction, and rather than cut a new opening and build a whole new surround, the existing window opening was simply extended down to floor level and its dressed-stone sill reused at a lower level. When and why such a modification was thought necessary cannot be ascertained, but Franquet's initial inspection report noted that one section of the building was for the soldiers, a smaller section being reserved for the officer.[57]

Under these circumstances, some indication of an interior division might have been expected, but there were no positive traces. The entire floor was of cobblestone, featureless except for three apparently deliberately made holes in a line 1.45 m from the rear wall. Two plans (Figs. 161, 162) indicate a wooden feature running the length of the rear wall and most logically interpreted as a communal bunk for the troops stationed within the bastion. Identical features are shown in great detail in various profiles and plans of guardhouses illustrated by Masse[58] (Figs. 194, 195).

The only other identifiable feature within the barracks was a large fireplace in the southeast wall. Originally of a simple square design with a surround of dressed sandstone and a lining of brick, its size had been reduced by a secondary blocking of brick, possibly in an attempt to reduce heat loss up the chimney. The fireplace had seen considerable use to judge from the signs of intense heat on the hearthstones associated with the modification.

The fireplace was the only source of heat identified for the building. If a section of the interior had been partitioned off, thus necessitating a separate entrance from the bastion terreplein, the smaller area would have lacked a source of warmth unless there was a free-standing stove with a chimney pipe through the roof, but this remains in the realm of speculation.

Being partially buried in the rampart, the rear wall had survived to the greatest height of any feature associated with the building, but no other indication of the structure's appearance above floor level was observed. The cobble floor, covered with only a thin layer of turf prior to excavation, was remarkably free of any collapsed material, as was the nearby surface of the bastion terreplein. The walls were masonry to eave height, most likely a little above the level of the rampart terreplein. Above this rose a hip roof (Figs. 161-164) covered in wooden shingles according to Franquet.[59]

Some 3.6 m from the barracks, the powder magazine was also set with its long axis parallel to the left face. From the exterior it appeared almost square, measuring 9.9 m along the rampart axis and 8.53 m from front to rear, but inside the building the situation was reversed, the distance from front to rear being greater than that from side to side. The side walls had been built to massive proportions, 2.44 m thick, to support a masonry vault, whereas the front and rear walls were only 1.1 m thick. The spring of the arch and an inner lining of bricks could still be observed in the excavated structure (Figs. 188, 189).

All four exterior corners were built with carefully cut sandstone quoins. Although at the rear of the building (the south and west corners), the quoins did not extend to the base of the wall, they continued down well below the level of the rampart terreplein. Had they been used, even though they were to be covered by rampart fill, because of the better, tighter bonding that could be obtained, or had there simply been a change in plan and the rampart raised higher than originally intended? As the magazine seems to have been built at the same time as the left face rampart,[60] a change in terreplein level does not seem plausible. It is possible that the initial intent was to leave a hollow space behind the magazine, but excavation revealed this not to have been the case for very long, if at all: large stones had been piled against the wall to eave height, thus preventing the earth of the rampart from coming into direct contact with the wall. The same phenomenon was observed behind the rear wall of the barracks, and in both cases the intent had obviously been to reduce moisture build-up. The walls had been founded on a level surface which bore no traces of weathering and normal soil development; the A and B horizons had been stripped away by the builders. The compact glacial till thus exposed can scarcely be considered freely draining soil, but the stony fill against the rear walls represents the only attempt to drain water away from the walls. No drainage courses or coarse material of any kind were installed at foundation level. Inside the magazine, traces of two layers of planks at right angles to each other and set on rough joists laid on the ground indicated that a double floor had been laid in an attempt to counteract rising damp. A little surprisingly, there were no post-holes in the walls and no ledge to support the joists, so the builders do not appear to have taken the most sensible course of raising the floor above the ground.

The sole means of access to the magazine was by a centre doorway in the terreplein wall. As a safety precaution, the surround of dressed stone on the exterior was duplicated by one on the interior so that two doors, one behind the other, had to be opened. The outer door, hinged on the left, swung outwards, and the inner door, hinged on the opposite side, swung into the magazine. The entrance as a whole had been well preserved, with a wrought-iron strap to prevent undue wear on the bolt-hole of the outer door still in place. An outside step, also of sandstone, had been carefully cut, but showed little sign of wear and had been covered with planking. Whether this was intended to reduce wear or to avoid any possibility of sparks being struck from people's boots as they entered the magazine cannot be determined.[61]

Not enough had survived to determine with complete certainty the form of the masonry vault that the side walls supported, but a basic semicircular curve was suggested by the spring of the arch and an inner lining of bricks that could still be seen in the structure (Fig. 189). A barrel vault would have been the simplest and strongest method of spanning the structure, at the same time providing it with a solid, bombproof covering of thick masonry. The top of the vault was not left exposed. All plans and views consistently show a gable-ended roof,[62] which Franquet noted was covered with wooden shingles. The outer surface of the masonry vault had survived in such good condition that the recesses for the rafters were still clearly visible (Fig. 187). In addition, the eaves overhung the side walls so that the recesses for the end rafters had to be accommodated in the top-most course of quoins.

Compared to the typical or "ideal" model, the structure in the Dauphin Bastion was recognizably a powder magazine, comparable to those illustrated by Masse (Fig. 190), but scarcely an outstanding example. In the thickness of its side walls, required to support the load of the vault, the building conformed to the specifications Belidor recommended.[63] However, in size it was much smaller than any considered by Belidor or the one designed by Chaussegros de Léry for the defences of Quebec in 1726.[64] Belidor specifically cautioned against inadequately ventilated floors which would result in excessive dampness and early rot, but Verrier had not kept abreast of his discipline if conformity to Belidor was anything to go by. He had allowed for ventilation through small openings on either side of the entrance, as excavation revealed, but this would not have compensated for the problems caused by setting the floor joists directly on the ground.

The double-door design was in keeping with time-honoured practice, but two other features almost universally associated with powder magazines were lacking. No buttresses provided additional support along the side walls, but since the walls were as thick as those Belidor recommended for a building almost twice as wide, such reinforcement was structurally unnecessary. The other missing feature was an outer perimeter wall. Belidor ascribed only one function to this wall -- to keep unauthorized persons from getting too close to the magazine. However, in the event of an accident causing an explosion, a perimeter wall might also limit the effects of the blast. Possibly the location within the enclosed bastion was felt to be secure enough.

The powder magazine of the Dauphin Bastion cannot be deemed an unqualified success. The masonry did not dry out and it was feared that powder stored there would become damp and useless.[65] The governor of the town calculated that a maximum of 200 barrels of powder could be stored there,[66] and a few years later, Verrier realized that a much larger magazine was required and submitted a proposal for one to be located in the otherwise empty interior of the Queen's Bastion.[67] Another proposal would have located the new magazine in the Princess Bastion.[68] Neither proposal was acted upon, although the magazine in the Queen's Bastion is frequently shown on plans until 1745 (e.g. Fig. 84). A new magazine was not built until after the French returned in 1749, when it was located inside the Brouillan Bastion to replace the one originally built there by the New England forces (Figs. 94, 100). The proposals and the later magazine actually built conformed more closely to the typical in size and in having buttresses and perimeter walls.

There is no record of the Dauphin magazine ever having received a direct hit, but it was certainly in a very vulnerable position within the most exposed bastion which bore the brunt of two sieges. Its location was understandably of considerable concern to Governor Duchambon, who during the first siege ordered the powder stored in the much safer shelter of the postern tunnel in the King's-Queen's curtain wall.[69]

The roof did sustain some damage. When the rear of the building and the adjacent rampart were excavated, a mass of rubble masonry, crudely keyed to the top of the northwest side wall and extending onto the terreplein and interior slope of the rampart, was exposed (Figs. 171, 187). It was likely intended in some way as a repair to the magazine. During the New England occupation, the roof must have required some attention, as Hopson and Bastide reported succintly that "the Powder Magazine ... has been repaired and a new covering put upon its Arch,"[70] while Boucher commented on the sad state of repair in which he found the building.[71] Nevertheless, it remained in use for the rest of the French occupation, presumably only being abandoned with the fall of

Louisbourg. With the rear of the roof supported by rough repair work, the magazine must have seemed rather shabby in comparison with the neat little structure it had been initially.

Officer's Guardhouse

As far as the original design was concerned and well into the 1750s there were only two buildings within the interior of the bastion, but a small, later structure was unexpectedly encountered on the terreplein in front of the barracks (Fig. 171). The building was a simple rectangle only 4.95 m long and 4.19 m wide with a fireplace in the northeast wall; there was presumably only one room. The walls were of rubble masonry set in lime mortar, and at each corner were sandstone quoins which appeared to have been originally cut for another purpose and reused here as convenient blocks. Because the structure lay close to the present-day surface and had virtually no covering of soil, the few artifacts recovered could not be regarded as reliable dating indicators.[72] Documentary evidence suggested a date somewhere in the 1750s. Such a building appears on only two plans: a rather crude plan of the whole town and fortifications dated 1757,[73] and a British plan made after the demolition of the fortifications, on which the barracks and an adjacent structure are identified as "Guard Houses almost in Ruins."[74] The building would thus appear to have had a very short history. While no other documentary references to it are known, its function may be inferred from modifications Franquet made to the gate area in 1756. To strengthen the defences there, the guardhouses were demolished and the rampart thickened (see below). With no Circular Battery to separate the interior of the bastion from the road, the old barracks could serve as the soldiers' guardhouse, but with no officer's guardhouse behind the gate, new quarters had to be found for him. The structure built next to the barracks, using material borrowed from the dismantled guardhouses, likely fulfilled this need.

Tenaille Front: Guardhouses

The poorly contrived section of fortification extending from the flanked angle of the bastion to the shore, referred to as the tenaille front, was for the most part devoid of regular ramparts. The reason for this was the existence of the gate itself, which split up the front, and two guardhouses, one on each side of the gate, which effectively occupied most of the available space.

The larger of the two guardhouses -- the soldiers' -- was designed with considerable economy of construction. The west wall, overlooking the ditch, was simply the escarp wall of the bastion, while the north wall, fronting on the road through the gate, was a narrowed continuation of the escarp of the Circular Battery. Thus only two extra walls had to be built to enclose the rectangle and retain the rampart fill of the battery to the east and that of the short right face to the south. Pronounced ready in 1729,[75] it appears to have undergone little modification until 1745. During the siege the whole front was badly damaged and the guardhouse had to be almost entirely rebuilt by the occupying forces.[76] Whether any further work was done by the French when they returned is not know, but by 1756 Franquet had decided to strengthen the entire front by backing it with a solid rampart (Fig. 97). By the time Wolfe's artillery had done its work during the second siege, little solid wall was left; it needed complete rebuilding according to the British engineer's report.[77] The demolition work delivered the *coup de grâce*, bringing down the escarp wall of the tenaille and spilling the cavalier fill over the site. It is scarcely surprising that excavation contributed little to our understanding of the structure.

The as-found foundations revealed a somewhat longer structure than that suggested by the pre-1745 plans indicating that the guardhouse did not extend into the rampart to the full width of the Circular Battery, its rear wall joining the tenaille escarp some 10 *pieds* (3.25 m) short of the re-entrant angle. However, the rear wall that was found did join the tenaille at the re-entrant angle. If the earlier representations of the guardhouse were correct, then the building had been enlarged at some stage, although supporting evidence is scant. Franquet's 1751 plan (Fig. 87) shows the guardhouse occupying the entire space behind the escarp between the re-entrant angle and the gate, but the scale is small and there is little structural detail. The rear wall of the excavated guardhouse did not appear to be as well built as the other walls and did not have as solid a foundation, so it could have been a later addition. Similarly the east wall was solid and well made for three-quarters of its length, but the remaining section, which met the rear wall, was poorer and had shallower foundations. If the building had been enlarged, one would have expected to find traces of the original rear wall, but none were located.

The front wall of the guardhouse also underwent changes. As depicted on the most detailed plan (Fig. 167), the wall, although an extension of the Circular Battery escarp, was nowhere near as thick. This is only logical since an 8-*pied*-thick wall would have occupied a disproportionate amount of space and left no room for loopholes next to the gate. The excavated foundations were only 1.22 m thick and were probably somewhat larger than the wall itself, which appears to have been built to the one-in-six batter of the Circular Battery escarp. Located in the collapsed rubble across the foundations were eight dressed stones identifiable as jamb stones from a doorway; the wrought-iron pintle was still set in one stone. All were cut to a batter of one in six on their outer faces and likely came from the guardhouse doorway.

In a mass of collapsed masonry close to the gate were found the remains of a brick-lined vault (Fig. 192). It had presumably formed the roof of a short passageway through the wall and into the guardhouse; however, with a wall no thicker than that indicated by the foundations and Verrier's plan, such a vaulted passageway would not have been required. Although incomplete, an intact section 1.51 m long was measured. At the time the passageway was in use, the front wall of the guardhouse must have been much thicker, although the modifications had not been carried out below road level, leaving the original foundations undisturbed. The most logical time for the work to have been done was during the 1745-49 occupation when the New Englanders rebuilt much of the guardhouse. With the Circular Battery in ruins and extensive repairs to the ramparts going on, this would also have been the logical time for enlarging the guardhouse. Whether the jamb stones found were associated with the rebuilding or had been discarded from the original, ruined doorway and simply incorporated as rubble cannot be ascertained.

Franquet's plan of the existing works (Fig. 87) appears to support the argument that the north guardhouse wall he found was the same thickness as the end of the Circular Battery escarp, now used to retain the cavalier, but he did not leave the situation unchanged for long. By 1756 the guardhouse had been filled in and a thicker front wall built into the roadway. The whole area had been transformed into a solid rampart abutting the escarp of the tenaille as far as the gate. There was now no room for a permanent squad of soldiers stationed behind the gate, only a single guard who could step back into a small niche in the wall when traffic came through the gate or in times of inclement weather (Fig. 171).

Excavations thus yielded information that was essentially limited to dimensions in plan; with the exception of the doorway surround and the brick vault, nothing about the structure above its foundations could be deduced. The most useful source is Verrier's plan and elevation (Fig. 167), but this allows us to visualize only the original, unmodified design. As he depicted the guardhouse, it had a single, inward-opening door with a window on each side of the door. The east wall was taken up by a wooden-plank bunk similar to the one in the barracks. In the centre of the west wall was fireplace with a brick chimney. Set in the west wall at floor level were two sets of musket-slits, angled to permit fire across the drawbirdge. In the parapet were two more sets of musket-slits, implying an upper firing level on the inside. Since no profile is given through the building, there is no means of determining whether there was a second storey or simply a narrow platform behind the upper openings. The roof appears to have been a lean-to structure sloping down from the top of the tenaille escarp towards the rampart terreplein of the battery, and was likely covered with wooden shingles. Running the full length of the front wall was a porch or gallery with a lean-to roof supported by posts. A regular feature of guardhouses, it allowed the guard detail to be in a state of readiness while under shelter. The guardhouses illustrated by Masse all exhibit such a feature

(Figs. 194, 195), as do most of the surviving examples in France.

The officer's guardhouse obviously suffered a closely allied fate. Excavation revealed only a simple rectangular foundation devoid of all detail. An extension to the east must have represented a masonry wall designed to retain fill from spilling onto the road when the guardhouse was abandoned and a solid rampart was banked up against the short section of tenaille escarp between the gate and the quay. The quay wall had been repaired following the first siege, and several reused dressed stones, several of which had originally formed parts of a window surround, were observed in the quay wall adjacent to the guardhouse. This was the only evidence to corroborate Verrier's depiction of a simple one-storey structure (Fig. 167). There was one doorway, with one window next to it, in the wall overlooking the road; another window faced east through the wall perpendicular to the quay. Through the tenaille wall and the wall above the quay were musket-slits. A small bed was in the northeast corner and a fireplace in the wall opposite. There was no outer gallery.

Tenaille Front: Latrine

Excavation designed to define more closely the relationship between the soldiers' guardhouse and the end of the Circular Battery revealed a small square structure tucked into the angle formed by the escarp of the battery and the east wall of the guardhouse. Carefully cut sandstone steps led down through the escarp to a brick floor that did not cover the entire bottom of the subterranean compartment but ended abruptly in an open pit. The floor was supported on a vault that continued as a rubble-stone tunnel beneath the road, emerging through the quay wall (Fig. 171). The structure could thus be identified as a latrine draining into the harbour and probably flushed at high tide. No opening was apparent in the repaired quay wall, the drain having been completely blocked. The original opening was shown on one plan and elevation drawn by Verrier and dated 1734 (Fig. 168). There is theoretically no reason why the entrance would have been blocked before the wall was thickened when the soldiers' guardhouse was replaced by a solid rampart unless the entrance had been damaged in the first siege and the New Englanders had simply covered it over. The quay repairs, and hence the blocking of the outlet, were probably carried out during their short occupation. Although a large, dressed-stone surround would seem somewhat elaborate for a latrine entrance, the steps were certainly made of such stones; the jamb stones with the one-in-six batter could as well have come from this entrance as from the guardhouse doorway to which they have tentatively been attributed.

Tenaille Front: Gate

Situated between the two guardhouses was the town's main gate, the design of which was a major preoccupation of Verrier. His earliest detailed proposal was in 1729 (Fig. 166) and work proceeded rapidly on the main structure, which appears to have been largely completed by the summer of the following year,[78] although the drawbridge was not operational for another two years.[79]

In comparison with the principal gates of fortified towns in France at that time, the Dauphin Gate was quite modest (Figs. 192, 194). It had neither the embellishments nor the complexity of structure so characteristic of Vauban's creations.[80] Verrier's gate consisted essentially of two pilasters of dressed stone with a bascule drawbridge, counterbalanced by overhead swipe-beams, pivoting between them to provide or deny access across the ditch. Presumably a double door hinged in the conventional manner on pintles at the rear of the pilasters formed an additional barrier even when the drawbridge was down, although its existence is never specifically alluded to. Between the pilasters, rabbetted to received the drawbridge from one direction and the two leaves of the door from the other, the doorway surround was spanned by a shallow arch or lintel that Boucher rather grandly called an *attique*.[81] Since there was no storeyed arch over the entire gateway, as his term implied, it is better to think of it as a spandrel or tympanum. Surmounting it was a plaque carved with the royal coat of arms and flanked by two stylized fish. A double symbolism may have been intended: dolphins in honour of the Dauphin, and fish to emphasize the importance of the cod-fishing industry to Louisbourg's existence. The tops of the pilasters were crowned with terminals. In the earlier plan and elevation simple, pear-shaped adornments are shown, but in the later one neoclassical trophies, such as adorn the cornice of Les Invalides, are indicated (Fig. 167). The whole gateway was set on a protruding base, with a belt-course at road level. Below the pivots of the drawbridge was a sill of dressed stone, sloped to allow water running off the drawbridge to drain into the ditch and hence called a *bavette* (bib) although judging from the amount of masonry calculated, Boucher applied the term to the entire base.

Practically no trace survived of the gateway. Whatever had withstood the battering of the second siege and the demolition blasts was removed when the 20th-century road was laid. Only base courses that were below the roadbed were found *in situ* (Fig. 192). Fragments of limestone and sandstone with carefully carved mouldings were recovered from the excavations of the rubble fill behind the officer's guardhouse, from the ditch in front of the gate, and even from the fill of the cavalier. These fragments revealed that Verrier's concept had been carried out, but, interestingly enough, there was no complete correspondence between the evidence from the stones and any one elevation drawing. While the pilasters in the two most detailed drawings were essentially the same, consisting of deeply bevelled joints on the sides and an oblong panel in the centre, the capitals were different, those of the 1729 elevation being more ornate. Limestone fragments from a capital course corresponded to this earlier drawing. More limestone fragments from heraldic figures indicated that more complex terminals than those on the 1729 elevation had been installed, but they did not match the details in the 1733 drawing. Instead, they came from a somewhat simpler figure, such as appears to be depicted, at a much smaller scale, in a 1734 profile (Fig. 168). Three badly worn fragments had formed part of the cartouche containing the royal coat of arms, but showed a rounded form with different chain details from those depicted in 1733 (Fig. 167). The cartouche had been specially ordered by Verrier, who was anxious to use fine white limestone from Rochefort of a quality suitable to the project,[82] and arrived towards the end of 1731, ready to be installed the following year.[83]

Limestone was also used for most of the pilasters, although whether this also came from France is not specified. The stone is coarser and greyer than that used for the cartouche and could well be local. The elevations depict the oblong panels as a different colour and this, together with several smooth-finished sandstone blocks found in the rubble in front of the gate, indicate that the centre of the pilasters was sandstone. An interpretation of Verrier's gate is shown in Figure 254.

If various stones could be matched to more than one drawing, there may have been more than one gate; however, there is, little indication that Verrier's gate was ever rebuilt after the first siege, despite Boucher's estimates. Franquet's main concern was to strengthen the whole tenaille, replacing the guardhouses with a rampart, its parapet continuing over the roadway. His profiles show no gate structure, simply the bridge, the escarp and the enlarged rampart (Fig. 90). The entrance to the town probably became little more than a plain tunnel through the walls. Unfortunately, no views or elevations of the later work are comparable to Verrier's drawings of the original one. The best later depiction of the bastion is a general view showing the breaches made in the fortifications during the second siege (Fig. 241). The gate appears as a simple entrance in a continuous wall.

The drawbridge was probably repaired and continued in service. Hopson and Bastide blandly recorded that "the Ruined Gate and Gateway" had been "intirely Repaired,"[84] while Boucher acknowledged that the bascule and overhead beam to raise the drawbridge were again functional. Thus it is impossible to attribute with certainty the most interesting and unexpected feature recovered to a specific period. In order to open the ditch and drain the pond, the 1930s road surface and its bed were removed by heavy equipment. As the lower layers of roadbed were being cleared, fragments of wood began to appear, so manual excavation was resumed, revealing the entire frame of a drawbridge and a substantial portion of a fixed bridge on the opposite side of the ditch (Fig. 191). The framework of the drawbridge, over which heavy planking had been nailed, consisted of five longitudinal beams, parallel and equally spaced, tenoned into two larger transverse beams and reinforced with wrought-iron straps. On the ends of the transverse beam closest to the gate the massive iron pivots were still attached. The frame was nearly square, measuring 3.12 m x 3.28 m.

Boucher's estimates are the only documentary sources to contain any actual dimensions of the bridge. The most detailed elevations of the gate (Figs. 166, 167) indicate a drawbridge width of 10 *pieds* or slightly greater when scaled, but do not indicate its height in the raised position although it must have reached spandrel level and therefore would have been longer than wide. The lowered drawbridge depicted in Verrier's 1734 plan is 13 *pieds* long and 10 *pieds* wide (Fig. 168), and the other pre-1745 plans, albeit to a smaller scale, consistently reflect the same proportion of length to width. Franquet's 1756 plan, on the other hand, indicates a square drawbridge although the scale is too small to allow any dimensions to be taken accurately (Fig. 97). The dimensions Boucher gave for the *tablier* (the movable portion of the drawbridge) were 8 *pieds* long by 9 *pieds* wide,[85] which corresponds with neither the *in situ* remains nor the dimensions scaled from Verrier's most detailed drawings. It cannot be determined to what version of the bridge Boucher's figures refer; such a drawbridge would have been appreciably smaller than the one Verrier originally built. Possibly Boucher was trying to fit a new drawbridge into the entrance as modified by the New England troops, although this does not appear to have been the intent of his estimates generally.

The *in situ* remains were probably from a late phase in the gate's history. Certainly the various references from the time the French returned in 1749 until the fall of Louisbourg suggest many makeshift solutions and repairs to both the fixed and movable portions of the bridge. At one time, Boucher was proposing to patch it with material salvaged from earlier ones, on the assumption that there would eventually be a permanent gateway to a new design,[86] but he was soon forced to abandon this approach and use new materials when the weight of traffic caused the bridge to collapse.[87]

One of the terms of capitulation in 1758 obliged the French to build a new bridge to allow the English troops to march into the captured town.[88] Although the excavated drawbridge had hardware that would allow it to pivot on its base, there were no attachments to raise and lower it. The lack of any indication that it had actually functioned as a drawbridge suggests that, after the existing bridge was damaged in the last siege, a new bridge was set one last time in a permanently lowered position to enable the victors to enter the defenceless town.

Simple ramparts spanning the gap between two bastions, the curtains were a defensive screen for the town and a means of permitting rapid peripheral movement of troops. Since the active defence was conducted from the flanks of the bastions, the curtains were much less complex in design and, in terms of the information they could contribute to our understanding of the fortifications as a whole, of correspondingly less significance.

Only two sections of curtain wall -- between the Queen's and King's bastions and the King's and Dauphin bastions -- have been excavated; discussion will therefore be concentrated on evidence from these areas. Chronologically, the construction of the Queen's-King's curtain preceded that of the King's-Dauphin curtain in spite of the fact that Verrier -- under some official pressure -- had left the King's Bastion in an unfinished state in order to begin work on the Dauphin Half-Bastion. The latter, in particular the associated Circular Battery, was considered more as a vital component of the harbour defences than as an essential part of the landward *enceinte*; the possibility of a naval assault being considered the gravest threat to the settlement, construction of the Dauphin Bastion and the Island and Royal batteries was given even higher priority than completion of the citadel. Once this avenue of attack had been effectively closed, the landward defences could again be considered. Although the town was completely exposed to artillery fire in the area between the King's and Dauphin bastions, a direct frontal assault would not have been practical because of the open expanse of water and bog immediately before it.[1] If this could be commanded by the King's Bastion, Verrier felt that his next priority should be to complete the *enceinte* in the still-open southern extremity by working on the Queen's Bastion and the curtain connecting it to the King's Bastion. The curtain to the Dauphin Bastion could be assigned a lower priority.

King's-Dauphin Curtain

The exigencies of the terrain resulted in a somewhat extended front. The exact measurements may be derived from Franquet's survey: the exterior side (from flanked angle to flanked angle) of the the King's-Dauphin front was longer by 20 *toises* (39 m) than the front between the Princess and Queen's bastions, recorded as 168 *toises* (327.5 m).[2] Although no actual measurement for the King's-Dauphin line of defence was given, it may be scaled from Franquet's 1751 plan (Fig. 87) as approximately 148-150 *toises*. Both this distance and the length of the exterior side, while longer than on the other fronts, were nevertheless within the acceptable limits then recommended,[3] and the curtain length would also be acceptable. The only measurement known from documentary sources concerning the curtain length was that Boucher gave in calculating the amount of masonry repairs required.[4] His figure of 95 *toises* 3 *pieds* (186.2 m) corresponds well with the length of the excavated remains of the wall: 185 m. The small discrepancy is quite understandable when we recall that both the right flank of the King's Bastion and the left flank of the Dauphin Bastion were extensively repaired, thereby changing slightly the length of the curtain. Boucher was, moreover, probably calculating from the magistral line, so that the degree of batter on the respective flanks also affected the measurement of the wall.

Because the Dauphin Bastion was considerably lower than the citadel, the curtain had to be built in such a way as to maintain a reasonably consistent height for its entire length and to relate to the flanks at either extremity. The Franquet memoir stated that "the curtain descends 32 *pieds* in sloping steps towards the left flank of the Dauphin Bastion.... The left flank of the Dauphin Bastion, 4 *pieds* higher than the curtain, is level...."[5] (Author's translation.)

It is clear from the overall context that Franquet was describing the total drop in elevation.[6] Rather than being accomplished in one continuous slope, the decrease was achieved by a series of steps. Support for his description is most convincingly obtained from a view of the breaches in the ramparts at the end of the second siege (Fig. 241). Franquet's "sloping steps" appear to be clearly indicated. Earlier views, probably drawn from on board a ship in the harbour, reveal only a simple uninterrupted slope to the rampart from the King's Bastion down to the Dauphin Bastion (Fig. 161).

The plans are the least helpful. Without information from other sources, the bastions would appear to be on the same plane and the curtain horizontal in Verrier's 1735 plan, which purports to show the state of progress for that year and clearly indicates four different levels to which the rampart fill behind the curtain escarp had been raised. However, as this is described as "terrasée en partie," there is no way of knowing whether the finished terreplein of the rampart conformed to these levels. (Apart from this detail, the plan is identical to his 1734 plan, Figure 77, and is therefore not included in the present report.)

Archaeological investigations yielded little information that could clarify the issue. Prior to excavation the curtain consisted of a series of low mounds between the two bastions, the depressions caused by demolition blasts being evident close to the King's Bastion; in the area of the pond and toward the Dauphin Bastion, the ground was almost flat (Figs. 68, 253). Much of the rubble and earth must have been removed for construction activities after the abandonment of the French town in the same way that parts of the Dauphin Bastion had been. As is typical of the ruined ramparts of Louisbourg, the part of the curtain that had spilled forward into the ditch appeared as a gentle, grassy slope with a broad scattering of rubble at its foot. Toward the northerly end of the curtain, where it joined the Dauphin Bastion, the rubble was for the most part submerged in the water or marshy edges of the pond. In the absence of any clear indication of the escarp's alignment, test trenches were laid out parallel to the east-west co-ordinates of a survey grid established to record the pre-excavation terrain. In two cases only was the elevation sufficient to suggest that the terreplein level of the rampart had been located, but in neither case were the strata as clear and unambiguous as those observed on the flank and face of the Dauphin Bastion. Low rises in the original terrain had been incorporated in the rampart; the distinctively coloured B horizons of the undisturbed subsoil had survived, with redeposited fill overlying them, providing minimum elevations below which the terreplein could not have been established. The evidence was far too fragmentary to permit positive identification of the terreplein level over any appreciable distance.

Once sections had been taken across the escarp at intervals, the entire base of the wall was exposed using mechanical excavators and a raised pad in the pond. Not unnaturally, the foundations followed the contours of the terrain, sloping irregularly from the high point at the right re-entrant angle of the King's Bastion to the left flank of the Dauphin Bastion (Fig. 134). The decline in elevation was 7-0 m above sea level, considerably short of the 32-*pied* difference Franquet recorded for the upper part of the wall. There were no abrupt or sharply defined changes in level that could be confidently correlated with steps in the terreplein, but a superimposition of the three ramps depicted on the 1758 view (Fig. 241) on the exposed remains was not incompatible with the base elevations.

The wall was never very high. In the preliminary stages of construction Verrier felt confident that the town could be considered secure once a height of 10 or 12 *pieds* had been achieved.[7] This would not, of course, have been the finished height, and the parapet would yet have to be added. With his work proposals Verrier submitted a plan indicating progress to date which included profiles of the various curtain walls as he envisaged them in their completed state (Fig. 77). Unfortunately, that showing the King's-Dauphin curtain was taken in the area of the pond and included a high foundation in order to raise the escarp above the water level. Thus the total height of masonry is in excess of 25 *pieds*, but the escarp proper is slightly less than 18 *pieds* high and is surmounted by a parapet with an exterior revetment 4 *pieds* high. However, even the lesser height for the escarp proper is not consistent with Franquet's comment that the curtain was 4 *pieds* lower than the flank of the Dauphin Bastion; Verrier's proposed height would have put both ramparts at the same level.

The weight of the evidence indicates that Verrier did not finish the curtain as he had intended. While the dimensions Franquet gave cannot be entirely reconciled with elevations derived archaeologically, we may at least trust his assertion that the curtain was lower than the Dauphin flank. There is, moreover, a close correlation between the archaeological sections across the curtain at its highest points and the profile indicating the condition of the fortifications as Franquet found them (Fig. 91). If the change in strata from a slope to a horizontal surface observed in section is indicative of the terreplein level or close to it, then the height of the escarp is no more than 4.57 m (14 *pieds*). Regrettably, the height from the base to the existing terreplein level is not one of the many dimensions actually marked on Franquet's drawing, but the scaled height is 2 *toises* 2 *pieds* or 14 *pieds*.

The correlation also provided interesting evidence concerning the interior slope of the rampart: the slope Franquet recorded was almost exactly that revealed in section. Whatever the engineer may have done to the parapet, he did not alter the slope as his drawing showed was his intent. Furthermore, the degree of slope is not in accord with Verrier's proposal; this aspect of the curtain too was modified in the course of construction.

As access to the outworks was of vital importance to an effective defence, provision was made for a sally-port or postern tunnel at each end of the curtain. The King's and Dauphin posterns, located at the junctions between the curtain and the respective bastions, were so designed as to angle around the ends of the flanks, thereby making optimum use of existing walls and at the same time ensuring that the resulting passageway could neither be taken too readily by direct assault nor enfiladed from one end to the other. Two posterns were perhaps desirable because of the extended length of the front, but the primary reason was the lack of communication between the covered way in front of the King's Bastion and its equivalent in front of the Dauphin Bastion. As initially constructed, there was a large gap occupied by the pond, so that while troops could move up and down the curtain freely, they could not do so on the covered way or in the ditch. Thus troops coming from the citadel via the southern tunnel would be restricted to the covered way immediately to their front; similarly, troops from the Dauphin garrison would be confined to the isolated outworks between the pond and the harbour shore. Where the terrain required it, as at the Dauphin postern, access to the outworks was by footbridge.

The curtain wall being virtually non-existent in its more northerly sector at the time of excavation, it is not surprising that little remained of the Dauphin postern. It is difficult to reconcile the fragmentary and distorted base of its passageway with the right-angled turns depicted in Verrier's plans. If anything, the surviving courses suggested a curved rather than angular tunnel (Fig. 171). Essentially, however, the layout presents no problems. A narrow doorway, set almost against the flank of the bastion -- and partially obscured by it during the post-1745 refacing work -- gave directly onto the ditch. The passageway behind it led through the escarp, turned north to run parallel to the curtain wall, and finally turned east again, emerging in the masonry retaining wall that served as the junction between curtain, flank and Circular Battery. Of the townside doorway, only one side of the passageway was found intact; the jamb stones had disappeared. The outer doorway, although more vulnerable to direct artillery fire, was better preserved. A sandstone sill was found *in situ*, together with two jamb stones and a wrought-iron pintle partially obscured by the repaired flank. More jamb stones of the doorway and the second pintle were found in the mud at the bottom of the ditch. No stones from the arch were recovered.

At the southern extremity of the curtain, the King's postern had survived in far better condition, its vault being intact for much of its length (Figs. 142, 196). The worst damage had occurred in the section through the curtain escarp, where the vault had collapsed as a result of a nearby demolition charge. Both doorways were still evident. That overlooking the ditch had collapsed forward, leaving only the sill and a few jamb stones in place, but the reassembled stones gave a complete picture of the feature (Fig. 198). The townside doorway and vault had survived with more jamb stones *in situ*, although stones from the arch were missing.

The design was carefully thought-out, using a minimum of labour and materials, and exploiting existing features to the full. The massive terminating wall of the right flank, which would have been fully exposed when the King's Bastion was a free-standing redoubt prior to the construction of the curtain walls, was used as a solid support to which much of the vault of the tunnel was attached. From the opening through the curtain escarp near the flank, the tunnel turned at a right angle to follow the terminating wall of the flank, then turned at another right angle to follow the barracks counterscarp to emerge onto the covered way of the townside defences. Had the postern not been built, the upper continuation of the barracks counterscarp would still have been required to retain the earth of the curtain rampart.

The postern's association with some of the most solid masonry in the entire *enceinte*, its well-constructed vault and a thick covering of earth all combined to assure a high degree of preservation. The exterior doorway was vulnerable, if not as a target in its own right, then by virtue of its proximity to the exposed and heavily bombarded right flank of the bastion. The whole area was badly damaged in 1745, necessitating total rebuilding of the escarp. The way in which the timber uprights built into the flank had been partially obscured by the masonry of the curtain between the doorway and the re-entrant angle suggested that the entrance to the postern had also been extensively repaired, an impression reinforced by the observation that the *in situ* sill stones had been reworked to fit their present location. On the underside of the sill stones, rabbets similar to those cut into stones reliably associated with the window surrounds of the barracks were still clearly visible. The sandstone quoins which marked the original corner of the bastion were in part obscured by the addition of the curtain and in part removed, to reappear as rubble in the 1755 reconstruction of the flank. It is thus reasonable to postulate two phases of modification to this area, one initiated by construction of the curtain and the postern, the other by damage during the first siege.

There is one possible exception to the disappearance of all archaeological information pertaining to the parapet. Above the vault of the King's postern was a well-constructed stub of masonry wall, the upper portions of which were missing although the end and inner face were still intact (Figs. 142, 196). Butted to the terminating wall of the flank but bonded to the masonry of the vault, it was evidently built at the same time as the postern. It could have served no useful purpose as far as the flank was concerned, but may have been the end section of the interior revetment of the curtain parapet, although the distance between its inner face and the projected alignment of the curtain escarp is no more than 2.13-2.44 m. The implication is therefore that the parapet Verrier proposed, which is shown as 15 or 16 *pieds* wide (as scaled from his profile, Fig. 77) was never built. Franquet's report lends substance to this argument. Besides criticizing the curtain as being far too low, he found the parapet too weak, too low, and incapable of withstanding cannon fire.[8] While no dimensions were given, the original parapet as he recorded it in profile scales to no more than 8 *pieds* (2.6 m) (Fig. 91).

Of any other features on the curtain there was no trace. The departing British recorded in 1749 that they had attempted to improve the curtain defensive capabilities by adding two masonry-revetted traverses of earth and inserted two embrasures above (i.e. nearer the King's Bastion) the upper traverse.[9] This arrangement seems to have been maintained by the French, as indicated by Franquet's plans (Figs. 95, 97), and may have accounted for the isolated high points along the curtain permitting us to observe the terreplein level still intact in two places; however, no evidence as to the nature of the traverses themselves was found. By 1755 Franquet had, by his own admission, been unable to attend to most of the desired repairs on this front and there was no likelihood that much could be done.[10] It is clear that the curtain remained in much the same state as Franquet found it until its final destruction.

Queen's-King's Curtain

The hill on which the King's Bastion was located was appreciably higher than that selected for the Queen's Bastion, and once again the Franquet memoir provides the most explicit description of the curtain: "built on a slope, rising 8 *pieds* 9 *pouces* to the left flank of the King's Bastion".[11] (Author's translation.) Such a slight rise could easily be accommodated in a gradual but continuous slope; the steps required for the King's-Dauphin curtain were not necessary here. Moreover, the Queen's-King's curtain was appreciably shorter than the other. Franquet merely described the dimensions of the whole front in general terms, comparing it to the previous front he had considered in his report (the Princess-Queen's). His plans show no difference in length between the curtains of the two fronts, both of which scale to approximately 70 *toises*. However, preparing detailed estimates for quantities of masonry to repair the escarp, Boucher gave the specific figure of 72 *toises*.[12] The length of the excavated remains of the curtain, as measured at the base of the escarp between the right re-extrant angle of the Queen's Bastion and the left re-entrant of the King's Bastion, was 140.1 m, whereas Boucher's 72 *toises* converts to 140.4 m.

Although the curtain was set on fairly even ground with no pond on its alignment, construction did not proceed as smoothly as had been expected. Once excavation for the foundations had begun, bedrock was discovered close to the surface, which not only caused difficulties in digging the ground, but also meant that locally the water table was high.[13] Once digging began and the surface lowered beneath that of the surrounding terrain, areas of open water began to form. More by accident than design, Verrier had incorporated another pond, this time of his own making, in the outworks.

Following this initial set-back, work progressed at a satisfactory pace, so that by the end of the 1733 construction season the escarp was raised to its full height ("elevée entierement jusquau cordon"), but without its parapet.[14] Since the intent was then to press ahead with all the defences as far as the southern shore, the curtain could safely be left in this state while work proceeded on the other ramparts.[15] The parapet of the curtain was added later, along with those of the Queen's Bastion.[16]

From all appearances, the curtain was built much higher than its counterpart on the other side of the King's Bastion. The average height of the escarp without the parapet was given by Verrier as 20 *pieds* on his 1733 plan (Fig. 76), and Boucher gave the total height for escarp and parapet as 4 *toises* (24 *pieds*).[17] Boucher's estimates are consistent with Verrier's plan and profile of 1734 in which the height of the completed escarp may be scaled as 20 *pieds*, the proposed parapet as 4 *pieds*. The Franquet drawing shows an even higher wall: a dimension of 28 *pieds* 5 *pouces* is marked against what appears to have been the existing height of the wall (Fig. 92). A discrepancy of 4 *pieds* thus exists between Verrier's and Boucher's figures on the one hand and Franquet's field measurement on the other; however, the former are average dimensions whereas the latter purports to be at a particular point half-way along the curtain. It is possible that the wall was as high as Franquet claimed at this point, since the height, or quantity, of masonry would vary in relation to the bedrock.

No evidence suggests a difference in elevation between the curtain and the flanks of the bastions it joined. The archaeological investigation was unable to corroborate this, but a possible terreplein level was observed at an elevation of 14.63 m at a point 18 m from the curtain's junction with the left flank of the King's Bastion (Fig. 202). As the terreplein level of the latter feature was calculated as being at 15.7 m above sea level, the presence of a similar level on the curtain wall is consistent with all known evidence.

A less satisfactory correlation exists between the various historical sections or profiles across the rampart and the archaeologically observed features. The slope of the rampart appeared much more gradual than either Verrier or Franquet indicated, its point of contact with the ground-level within the town being some 22 m from the rear of the escarp. If the distance between the same points is scaled from the Franquet drawing, it measures no more than 10 *toises* 3 *pieds* (20.47 m). However, a pre-excavation aerial photograph and contour plan revealed that the curtain rampart was noticeably thicker near its junction with the King's Bastion than elsewhere. This may be due in part to disturbance of the ground caused by demolition activities, but the interrupted nature of the slope, as seen in Figure 202, suggests that the ramp giving access to the terreplein of the curtain, shown in some plans (Figs. 78, 81, 82), had been constructed at this point and its bulk of earth fill was the cause of the enlarged rampart.

Of the parapet above the rampart, no positive traces survived. A rectangular patch of mortar was located some 5.8 m to the rear of the inner face of the escarp, but no masonry was associated with it and the distance to the escarp was considerably greater than any indicated in documentary sources. It most likely represented the remains of a batch of mortar left behind by the masons who worked on the interior revetment of the parapet. The Verrier and Franquet profiles (Figs. 75, 92) both basically agree on the width of the parapet, which appears to be roughly 2 *toises* 4 *pieds* (5.2 m).

Franquet did not find it necessary to increase the width in this case although he did propose raising the height.

Located midway along the curtain was a postern tunnel providing direct communication to the *place d'armes* in the covered way immediately across the ditch. Consisting essentially of a masonry vault buried in the mass of the rampart, it appears to have been the earliest element of the curtain to be finished;[18] the masonry of the escarp followed,[19] and the work of raising the earth fill in well-tamped layers was finally carried out in 1736.[20]

The postern differed from those in the King's-Dauphin curtain in several respects: it was located centrally; the passageway followed a gentle S-curve so that the inner doorway was not in direct alignment with the doorway overlooking the ditch; the townside entrance was set in the earthen slope of the rampart, and the existence of a passage through the escarp was exploited for drainage purposes as well as for communication.

The location is understandable. The curtain was much shorter than the one to the Dauphin Bastion and there was no problem of movement on the covered way; access to the *place d'armes* in front of the curtain by the quickest and most direct route was the main consideration. Set at a bias to the alignment of the escarp, the Queen's postern does not appear to have reflected an undue concern for military security, since an angular, zigzag plan could equally well have been used here as at the King's and Dauphin posterns, but its sinuous passage suggests at least a token gesture.

Design of the entrance facing the town was governed by the nature of the rampart. Being several feet lower than the terreplein, the postern tunnel did not emerge from the rampart fill until it intersected the slope of the rampart where a doorway was constructed of dressed sandstone (Fig. 205). Beyond the doorway on the townside the rampart slope was still sufficiently high to require retaining walls on each side of the flaring passageway -- open to the sky at this point. These walls were substantial, being over 1.2 m thick. The ends facing the town sloped up from the ground level to the top of the walls, which was presumably level with the extrados of the vault; the slope was held secure by dressed sandstone blocks, some of which were carefully cut, others more crudely shaped. It would be logical to assume that the degree of slope to which the stones were laid was identical to the slope of the rampart: the 45-degree or one-in-one incline derived from the stones reflects Verrier's even steeper slope of nearly 50 degrees in his 1734 plan and profile. However, the rampart sloped much more gradually and extended well beyond the ends of the retaining walls, which were covered by quantities of fill. Even allowing for natural settling of the slope and extensive disturbance by the demolition operations, it is apparent that at one time the rampart extended much further than had been originally intended. The Franquet profile, moreover, indicates that such a condition existed when the engineer made his survey; his proposed modification was to shorten the rampart by increasing the slope to an incline of one in one. The conclusion is that between preparing the proposals and actually raising the ramparts, Verrier decided upon a more gradual slope.

The ground in the postern area must have been extremely boggy prior to construction, as the soil horizons preserved beneath the slope of the rampart revealed a thick, black layer of decomposed vegetation on top of a heavily eluviated, boulder-strewn Ae horizon immediately above the water table. Such terrain caused construction problems which Verrier sought to resolve by channelling the water into the ditch. In order to do this, the water had to pass through or under the curtain and the easiest way of achieving this was through the gap created by the postern. As early as 1727 a channel had been dug parallel to the future curtain to drain water away from the work then in progress on the left flank of the King's Bastion,[21] and Verrier's 1737 plan clearly shows his intent to run a channel through the postern and join it to one, presumably that dug in 1727, following the ditch around the Queen's Bastion and down to the sea (Fig. 79). The drain under the postern, found substantially intact, consisted of a channel with rubble-stone sides and a flat-stone cover, overlain by stones and coarse gravel on which in turn was laid the postern floor (Fig. 205). In the face of the escarp the drain opening, arched in flat fieldstone, was immediately beneath the dressed-stone doorway of the postern. A wooden lintel supported by two short posts was set under the arch, possibly as a form of grill. Subsequent excavation demonstrated that throughout the width of the rampart the arch had in fact been supported by similar timber shoring.

It appears that the King's-Queen's curtain was built more nearly to the specifications indicated in Verrier's drawings than the later King's-Dauphin curtain; however, the slope of the rampart in both cases was much more gradual than originally intended, as the Franquet drawings and the archaeological sections attest.

Some problems common to both sections of curtain wall remain unanswered. Neither Verrier nor Franquet depicted a cordon course although Verrier frequently alluded to the cordon level as a means of measuring the progress of the construction. Did an actual cordon exist or was he simply using the term as another way of referring to the magistral line or rampart height? The total absence of any cordon stones, or of any dressed stone copings after the excavation of more than 325 m of walls and ditches strongly suggests that the curtains were finished much more simply than the bastions, perhaps because of the difficulties in obtaining good-quality stone and in having the work done. Nevertheless, even in those areas where evidence for a cordon course is much more positive -- primarily the King's Bastion -- the number of finds is surprisingly low.

While there was no direct archaeological evidence concerning the parapets, it has been assumed that the widths Franquet noted were those of the original features. These parapets, however, are depicted with an exterior revetment in the same plane as the escarp, whereas Verrier showed a vertical parapet above the escarp, but Franquet drew all his parapets as a simple extension of the escarps even in areas where evidence supported a vertical revetment. This being so, was Franquet more concerned with showing total height and thus used a stylistic simplification to indicate escarp and parapet combined or were all the parapets by that time in such poor repair that the exterior revetments were no longer distinguishable? There is no positive means of identifying the actual state of affairs. Because the parapets were built as separate features several years after the escarps and ramparts, there was no structural continuity to make an extension of the escarp a logical choice and parapets could well have been built with vertical exterior revetments as Verrier showed them.

Completion of the Landward *Enceinte*

The extension of the town's landward defences in a southerly direction as far as the open coastline was an essential part of the initial trace Verville prepared. When Verrier turned his attention in this direction during the early 1730s, he decided to push ahead with work along the entire sector, involving two fronts of fortification. Thus as work was proceeding on the King's-Queen's curtain, the escarps of the adjoining Queen's Bastion, the Princess Bastion and the Queen's-Princess curtain were also being raised. The ramparts as a whole were built up, starting with the King's-Queen's curtain, and finally the parapets along the two fronts added, those on the Princess Bastion being completed last.[1]

The area has not been subjected to the same intensive, integrated study as those previously discussed, particularly insofar as archaeological research is concerned; however, a brief review of the works to the south of the King's-Queen's curtain, based primarily on historical evidence, is necessary for an understanding of the interrelationship of the various components of the landward *enceinte*.

The Queen's Bastion

In most respects, the bastion which, together with the King's Bastion, formed the "double-crown" of the landward defences, was the simplest of Louisbourg's fortifications. It consisted of ramparts retained at the front by a masonry escarp, at the rear by an earth slope. The parapets of its faces were uninterrupted banks of earth retained front and rear by masonry revetments, and the narrower parapets on the flanks were pierced with embrasures at regular intervals, the merlons being of solid masonry. Other than a *guérite* at the flanked angle and ramps leading up to the terreplein of the ramparts, the bastion was devoid of additional features prior to the first siege. No casemates were incorporated in the ramparts and the gorge was completely open. Two aspects of the design that further distinguished the Queen's from the King's Bastion should be noted: first, in trace the polygonal figure on which the *enceinte* was based was irregular, resulting in curtains of differing lengths and hence different dispositions for the bastions. As Franquet had observed,[2] the perpendicular dropped from the side of the polygon was somewhat shorter than the norm -- 20 *toises* as opposed to 28 *toises* -- thereby producing a wide flanked angle and a correspondingly wide bastion. The same reasoning applied to the King's Bastion, the flanked angles of the two bastions being the same and their flanks of equal length. What made the Queen's Bastion the slightly larger of the two was the irregularity of the polygon, making the Princess-Queen's front longer than the Queen's-King's front. The difference was necessarily reflected in the respective curtain walls and in the left half of the Queen's Bastion. In practical terms, the right half of the bastion was a mirror image of the left half of the King's Bastion, but the left face of the Queen's Bastion was somewhat longer, thereby enlarging the work further than if it had been symmetrical.

The second distinguishing aspect of the bastion is that of elevation or profile. The King's Bastion being located at the highest point of the fortifications, there was a drop of about 2.75 m in elevation towards the Queen's Bastion. The land became progressively lower the closer it approached the coast, ending in a small embankment overlooking the stony beach. Clearly, the difference in elevation between this point, where the Princess Bastion was established, and the Queen's Bastion had somehow to be accommodated, and it would appear that part of the difference was made up within the bastion. In general, one would expect such changes to occur from one side of the capital line to the other, and indeed Franquet noted a climb of 5 *pieds* 10 *pouces* (1.9 m) along the curtain from the Princess to the Queen's Bastion, and a 2-*pied* 4-*pouce* (76 cm) rise along the Queen's left face to the flanked angle. There may actually have been a slight drop along the right face and flank before the curtain began its ascent towards the King's Bastion, but the description is vague and leaves in doubt whether Franquet is writing about the terreplein of the rampart or the parapets.[3] It is nevertheless clear that the Queen's Bastion was designed with less concern for vertical or horizontal symmetry than was felt desirable for the King's Bastion.

In the early 1740s Verrier had entertained the idea of situating a large powder magazine within the bastion, but the project was never realized. The open space was exploited by the occupying forces from New England:

> In the next Bastion called Denmark [as the Queen's Bastion was named by the British] are erected four Buildings two Storeys high each, which contain besides the Officers, the men of Two Regiments; the wings are 200 Feet long the upper and Lower ones 132, and form a quadrangle, whose court is about Sixty yards by Fifty. The lower Building intended for officers is not Finished.[4]

The buildings were of timber, cut to length in New England and transported for assembly on site.[5] Not surprisingly, upon their return the French took advantage of the quarters provided by their former conquerors. More meticulous in their recording than the British, they prepared an informative plan and elevation of the barracks they inherited (Fig. 206).

It is a time-honoured tradition in armies to have the men digging latrines rather than standing idle, and we may well suspect a similar motivation in Boucher's first project once he had completed his inspection and estimates of repair. A decision on what to do with the fortifications had to be made in Versailles, and Franquet had not yet arrived to assume direction of the fortifications. The defences were dilapidated in spite of makeshift work by the British and required immediate attention, but without any authority to proceed on major modifications, Boucher was obliged to turn his attention elsewhere: he built a magnificent latrine.[6] Its doors were of dressed stone, a vaulted sewer tunnel led through the left flank of the bastion and into the ditch, and its total cost exceeded 8000 *livres*.[7] The tunnel was large enough to survive as a mysterious crater in the ruined rampart, giving rise to local legends of a secret passage to the distant Island Battery. An impression of the work may be obtained from examining Boucher's plan (Fig. 207), and the outlines of the barracks quadrangle, the latrine and its sewer are all clearly visible in aerial views (Figs. 110, 208).

Queen's-Princess Curtain and Queen's Gate

Joining the two most southerly bastions of the landward defences was the shortest length of curtain,[8] which dropped some 1.9 m as it neared the coast. Little can or need be said about the curtain itself; its most remarkable feature was the gate midway along the wall. An entrance to the town at this point was first indicated on the plan showing the progress of work at the end of the 1733 season (Fig. 76); a detailed plan of the gate, drawn in the same year, shows what was intended (Fig. 209). A narrow passageway, revetted through the thickness of the interior slope of the rampart, is roofed as it passes through the rampart to permit free movement along the entire length of the rampart terreplein. How the roof was to be constructed is not clear, but a barrel vault such as was used in the postern tunnels would seem logical. Immediately over the roof of the passageway the terreplein appears to be paved with stone blocks rather than simply covered with earth and the fill of the parapet and banquette are held back by masonry retaining walls, creating, in effect, an open upper passageway leading to a machicolation cantilevered over the entrance. Three circular loopholes, presumably for light pieces of ordnance, complete the fundamentally Renaissance appearance of the work. The actual entrance, although entirely of dressed stone, is less ornate than the Dauphin Gate: there are no pilasters or bevelled joints, nor any trophies or royal insignia. The drawbridge simply pivots on hinges at sill level. To raise it, the counterweight has to be swung down into a chamber located beneath the entrance, at ditch level, and it is clear from the drawing that guards would have to descend a flight of steps into the lower chamber and pull chains attached to the end of the counterweight. No windlass or other mechanism is shown.

In the absence of specific references, we may assume that the gate was built at the same time as the rest of the curtain. Verrier's plan of work accomplished in 1735 shows the revetted passageway and the stairwell providing access to the counterweight chamber, although the earth of the rampart still remained to be laid in place. The following year he advised the minister of the imminent completion of this phase of the operation,[9] but the gate could not have been functional by then for a bridge still had to be constructed across the ditch. This was apparently not ready for at least two more yeas since a 1738 progress report noted the completion of the guardhouses behind the gate, but stated that there was no point in actually placing a guard there until the bridge was ready.[10]

Little mention of the gate was made thereafter. No repairs to it were included in Boucher's estimates, and work scheduled for the guardhouses was more in the nature of regular maintenance than of repairs to damaged structures.[11] In all of the various Franquet plans the gate is depicted in much the same way as it appeared on Verrier's original plan although, because of the scale, there is much less detail, and no elevations are given. It probably came through the first siege unscathed and retained its original characteristics for the entire history of the town.

To what extent the gate actually built conformed to Verrier's original specifications cannot be determined since the 1733 drawings are the best evidence and will likely remain so. As part of the works programme in the 1940s, an access road was bulldozed through the passageway and across the ditch to a parking area near Black Rock (Cap Noir) (Fig. 208). The ramparts on either side of the passage were retained by unsightly rubble-masonry walls which bore no resemblance to what had been there originally. No attempt was made to locate the remains of the gate nor to record any features encountered in the course of the work. In light of the surprises that awaited us at the Dauphin Gate, it would be unwise to assume that all traces of the 18th-century structures have been obliterated at the Queen's Gate, but the prospects are not bright.

The Princess Bastion

The landward defences terminated in an irregular work, graced with the name of the Princess Bastion, which was set on the coast of the open Atlantic overlooking a small, rock-strewn bay between Rochefort Point to the northeast and Black Rock to the south. If its counterpart at the other extremity of the fortifications was of unusual design, dictated by the terrain, the Princess Bastion was even more bizarre. In large measure its configuration was similarly influenced by attempts to overcome the disadvantages of the location, but subsequent revisions to the defence of the town also played a part.

As components of the Queen's-Princess front, the right face and flank of the Princess Bastion conformed to a regular bastioned trace; however, to the left of the capital line the design was quite different, evoking even more strongly the 16th-century "forked bulwarks" or *bastions tenaillés* than did the Dauphin Bastion. Where the left face would normally be in a regular work, a short section of wall at an acute angle to the right face (almost along the capital line) extended back parallel to the beach and then turned at a right angle toward the sea. The object of such a design was two-fold. In the first place, by angling back sharply on an alignment parallel to the shoreline, the construction problems that would have arisen by extending the bastion in a conventional manner down the low bluff and onto the beach were avoided, and secondly, in the right-angled re-entrant thus formed, a well-concealed battery could sweep the entire length of the shore as far as Black Rock. To the rear of the battery, the later addition of a left face and flank, conventional in plan, completed the outline of the bastion.

Verriere had determined upon a design that would, he felt, provide adequate defence against a landing in the little bay. Work proceeded at the same time all along the two fronts from the King's to the Princess bastions, so that the construction season of 1734 saw satisfactory progress in every sector (Fig. 77). The right flank and face escarps, the foundations of which had been laid the previous year, were now complete to cordon level and earth was being brought in for the rampart; the left face was not quite so advanced, but the concealed or retired battery ("batterie en retour d'esquaire") had been raised 10 *pieds*, and a *mur à meurtrière* had been vaulted over and brought to a height of 12 *pieds*.[12] This last feature was the most interesting and unusual element of the bastion, if not of the entire fortifications. As its name implies, the *mur à meurtrière* was a wall pierced with loopholes. A vaulted passage provided access to the firing positions; referred to as a casemate, it was more in keeping with the traditional function of casemates than the much larger structures also described as such in the King's Bastion but which had no provision for defensive fire. According to the 1734 and 1737 plans (Figs. 77-79), the casemate did not extent the full length of the loopholed wall, the most northerly positions being open to the rear. The vault allowed a parapet to be placed above the loopholes for added firepower, but primarily permitted the terreplein and parapet of the right face to extend as far south as possible. The side of the casemate facing the bastion interior thus served as a retaining wall for the slope of the right face rampart and did not extend beyond the limits of that slope.

The loopholes, of which ten are shown in both plan and view (Fig. 212), are depicted as inverted keyhole-shaped openings strongly reminiscent of the earliest accommodations to firearms in late medieval and Renaissance military architecture. In such contexts, primitive, small cannon would have been used; in the case of the Princess Bastion loopholes, light cannon were intended, as a request for ten cast-iron cannon of two-*livre* calibre for the loophole wall makes clear.[13] Small pieces, probably swivel-mounted, would have been fired through the circular openings at any enemy attempting a landing. The vertical slits would have been intended primarily for sighting, although conceivably muskets could have been discharged through them as well.

At a right angle to the loophole wall, effectively blocking the beach, was the small battery built to enfilade the shoreline. The name ascribed to it on the 1737 plan -- "Batterie du cap noir" -- is indicative of the concern felt over the outcrop of rock that offered both cover and a commanding position to an enemy approaching from the southwest. Furnished with three embrasures, the battery was substantially completed by 1737 (Fig. 212).

As a further safeguard against troops wading through the surf and entering the town undetected, Verrier proposed an *éperon* or mole extending beyond the battery into the water, but Governor St. Ovide began to express concern about the vulnerability of the town from the seaward approaches. He, too, felt that the bay below the Princess Bastion was a source of danger, but could not agree with Verrier's proposal. Instead, he was of the opinion that only a wall encircling the bay and terminating in a flank to complement the guns of the Princess Bastion would answer the purpose by covering both the beach and the open ground beyond. Furthermore, an extension of the wall across Rochefort Point to L'Etang de la Berrichon (later referred to as Grand Etang or simply Etang on the plans) would ensure the complete enclosure of the town.[14] He was, in fact, proposing a defensive measure which would embark the government on a new construction programme. Verrier, defending his *éperon* project, acknowledged some merit in the governor's proposals, but pointed out that a simple wall would not be adequate: to guard against a serious attack, all fronts should be "terrassé et bien flanqué."[15] If this was meant to discourage the government because of the cost, he miscalculated; the *éperon* project was dropped and the plans from 1737 onwards show a new *enceinte* consisting of two bastions facing east toward Rochefort Point, and a low curtain wall across the beach between the new front and the Princess Bastion (Figs. 78-80).

The initial effect of the new works on the Princess Bastion was to complete its outline, thus given it some resemblance of a regular bastion shape. The curtain wall to Rochefort Point was a low, lightly defended structure pierced with slits for musketry; it was presumably felt that there, at least, no danger of artillery bombardment existed. Although the firing slits were actually in the wall rather than on top of it, the feature is consistently referred to as a *mur crenelé* (Fig. 80); no crenellations are present and the term *meurtrière* would be more appropriate, but as the casemated loopholes are referred to as such, the avoidance of the term for the curtain wall, whether by accident or design, conveniently removes a source of confusion. One end of the wall was to be flanked by the new works, and the Princess Bastion end was to be similarly defended by creating a short flank turning at a shoulder angle into an even shorter face joining the Princess battery. Since the flank and face were to be an extension of the crenellated wall and of similar construction, they had no capacity for artillery. To overcome this handicap, a cavalier was raised behind and parallel to the flank. Completed in 1743,[16] the work appears to have had four embrasures (Fig. 84).

Ingenious though the overall design of the bastion may have been, the major problems influencing its design had been only partially overcome. To the south lay the commanding knoll of Black Rock, while attempts to confine construction to the glacial till of the land as opposed to venturing far onto the boulder-strewn beach had constricted the entire work far more than was desirable. The British, with some justification, dismissed it as "an ill contrived Break neck place"[17] and sought to improve upon it. By 1744 Verrier had had hasty second thoughts as to the efficacity of his design and had raised a battery on the right face which would, he assured the government, overcome any enemy battery established on Black Rock.[18] The British authorities were not satisfied as to the adequacy of such a measure and raised the rampart of the face even more.[19] They also proposed extending the face onto the beach and tracing a new left face and flank to produce the better proportioned, regular bastion that Verrier had not seen fit to build,[20] but the plan did not see fruition. The "forked" aspect of the bastion was retained, but the loopholes were blocked and the casemate used as a powder magazine.[21]

Nor when they returned were the French in a position to put into effect Franquet's more ambitious projects which would likewise have transformed the work into a spacious, regular bastion (Figs. 94, 100). He did succeed in prolonging the right face, raising and thickening the rampart at the same time. From the new flanked angle, now on the beach, a low left face extended back parallel to the old loophole wall to join the retired battery; both the battery and cavalier were retained because of their fire-power. Minor modifications were made at the same time to the crenellated wall in an attempt to improve its defensive capacity; however, the bulk of Franquet's efforts were directed towards improving the outworks (see below).

Subsequent to its demolition, the bastion's location, remote from the main focus of the town, isolated from the citadel and museum area by waterlogged terrain and an absence of access routes, had left it undisturbed by human intervention. This was unfortunately not true of natural events. The little bay receives the full fury of Atlantic breakers as they smash against the rock shore, and a gradual rise in sea level, in combination with autumn or winter gales coinciding with high tides, had pushed the beach further inland now and obliterated all trace of the crenellated wall.

The Princess Bastion was excluded from the intensive analysis applied to the King's and Dauphin bastions, although the historical documentation was examined in some detail,[22] but in the autumn of 1963, when dressed sandstone blocks, similar to those then being recovered from the King's Bastion, were observed lying on the beach or protruding from the earth embankment above, the archaeologists' attention was drawn to the site. The limited investigation carried out the following spring has been reported elsewhere.[23] Briefly, an intact section of the loophole wall had been exposed by weathering and wave action. The earth parapet above the wall had slumped forward onto the beach, giving the impression of an embankment and protecting the underlying masonry, but was now being washed away. Of the later addition virtually no trace had survived, but the original structure, albeit degrading fast, could be recorded (Figs. 211, 214, 215) and an entire *in-situ* keyhole-shaped gun-loop was recovered, together with stones from several others. The loopholes were blocked and, on the basis of English pottery located in associated strata, it was surmised that the work had been carried out during the British occupation 1745-49. Subsequent historical research confirmed this hypothesis. In the light of the archaeological investigation which had revealed structures still substantially intact and the unusual aspect of the bastion apparent from documentary sources, various recommendations were made to prevent further erosion and to preserve, or at least examine and record, the visible remains, but nothing was done at the time. The shoreline continued to erode and with it, the left face of the Princess Bastion.

Autumn gales of 1976 caused further damage, exposing remains of masonry, timber cribbing and even plank revetting, prompting an attempt to identify the surviving features in relation to the best available historical plans in order to determine how much of the bastion still remained.[24] The various phases of construction and the areas lost to the sea are illustrated in Figure 210. At last, in 1979-80, funds were allotted for the construction of a breakwater and importation of fill to reduce wave action and stabilize the embankment, all that remains of the left side of the bastion. The unusual nature of the loophole wall has no 18th-century parallels in France to the author's knowledge and is certainly unique to North America.

Thus far we have conceived of Louisbourg's landward defences as consisting of a single rampart, following a short arc, from which projected bastions to ensure flanking fire. It is time to consider further the question of defence in depth.

A significant feature of the defences in front of the ramparts, the ditch, was largely a natural outcome of the work of excavating material with which to build up the ramparts, an element of depth automatically being given to the defences as each sector was constructed. In considering each individual front of fortification, the outworks should properly be included in that front. For the purposes of this report, however, it is more convenient to discuss the entire line of outworks as a unified whole.

Defensive features between the country and the ramparts at Louisbourg were rudimentary in comparison with any European town of like size at the time. The outworks consisted simply of a ditch, counterscarp, covered way and glacis. As initially conceived, there were no additional obstacles in the ditch such as *demi-lunes*, tenailles or counterguards, nor were there any advanced or detached works in the form of horn-works or redoubts. Only in Franquet's later proposals were such works seriously considered, and these were for the most part rejected.

Understandably, completion of the ramparts was of higher priority than work on the outworks. Thus, while the ditch took rough shape at the time the escarp foundations were dug, the counterscarp, covered way and glacis lagged behind by several years. When work was undertaken, it was carried out on long sections.[1] Separated by the pond from the rest of the outworks, the outworks in front of the Dauphin Bastion were treated perforce as a distinct unit, but the work was nevertheless spread out over a decade; the counterscarp and parapet of the covered way were the first features to be built, beginning in 1730, and work continued sporadically on the glacis until 1739.[2] Elsewhere work continued throughout the period 1738-39, principally on the glacis, and a year later Verrier sanguinely noted that "the glacis of the old [landward] defences are completed, with the result that nothing is left to be done either inside or out"[3] (author's translation); however, criticism of the inadequacies of the glacis was a recurrent theme of Franquet's memoirs, and he asserted that the area in front of the Dauphin Bastion, at least, had never even been brought up to the level specified by Verrier.[4] A little earlier the British had also described the covered way as "unfinish'd at the Capital line of the Citadell."[5]

The outworks could nevertheless be considered in a defensible position by the early 1740s. A palisade had been erected in the banquette along the covered way during 1738 and 1739,[6] and a line of wooden posts driven into the bottom of the pond parallel to the Dauphin curtain wall provided an obstacle of sorts in the event of a direct assault or surprise attack, but offered no protection against artillery.[7]

Thus, prior to the first siege the outworks may be envisaged as a simple ditch, wet in some areas, dry in others, and bounded by a counterscarp that was interrupted by the pond in front of the King's-Dauphin curtain. The counterscarp in its turn retained a covered way, enlarged at intervals to form *places d'armes*. In front of the covered way, a glacis sloped down towards the country. At its highest point, the glacis rose sufficiently above the covered way to provide cover and an advanced firing position for infantry. A masonry retaining wall prevented the glacis fill from spilling onto the covered way, while an earthen banquette allowed soldiers to step up from the terreplein of the covered way and fire down the glacis as if it were a parapet. As a means of hindering a direct assault, a line of palisades was placed in the banquette close to the retaining wall, the posts being sufficiently far apart to allow troops to fire between them.

An overall impression may be obtained from the 1744 plan (Fig. 84) which indicates clearly the alignment of the counterscarp. At each extremity of the landward defences, a wall (*batardeau*) closing off each end of the ditch connected the counterscarp to the escarp of the main *enceinte*. Both *batardeaux* contained sluice gates to control water flowing from the ditch to the sea.[8]

The outworks in front of the Dauphin Bastion were isolated from the rest of the perimeter by the pond and had other unusual features. After a short, straight section parallel to the Dauphin tenaille front, the counterscarp curved around the flanked angle, a design imposed by the form of the bastion. Had straight lines mirroring the escarp been used a narrow, V-shaped salient would have been created in both the counterscarp and covered way. This was eliminated by foreshortening and rounding the angle, while the extra space gained on the covered way was profitably developed into a *place d'armes*. Where the counterscarp terminated at the pond, a symmetric *place d'armes* was not formed, probably because of the lack of firm ground and the desire to avoid the extra effort of building a firm bed in the waterlogged terrain. The low parapet formed at a right angle to the counterscarp, creating a bisected triangle or *demi-place d'armes*, was well situated to provide flanking fire along the barricade across the pond and to flank directly the termination of the covered way and glacis on the opposite side of the pond.

Another irregular *place d'armes* was located on the covered way in front of the right shoulder angle of the King's Bastion. The configuration of the ground permitted only a narrow, acute salient there instead of the more usual equilateral triangle shape, and the end was therefore rounded off. Thereafter the outworks extended conventionally to the *batardeau* at the Princess Bastion. Two spacious, regular *places d'armes*, one in front of the King's-Queen's curtain, the other in front of the Queen's-Princess curtain, assured complete flanking fire along the glacis and allowed sorties through narrow passages should the defenders so choose. At each extremity of the gorges of both *places d'armes*, access from the covered way into the *places d'armes* was restricted by traverses.

In the centre of the gorge of each regular *place d'armes*, two sets of steps built into the counterscarp provided access from the ditch. Additional double sets of steps may also be observed at the salients in front of the flanked angles of the King's and Queen's bastions, while a single set of steps opposite the King's postern assured communication between the citadel barracks and the *place d'armes* off the right shoulder of the King's Bastion.

To an otherwise extremely basic perimeter was added one refinement, indicated on the 1744 plan as a cruciform shape on the capital line of the glacis in front of the King's Bastion. Appearing on several undated plans which belong to the period of formulating various concepts of the defences in the early 1720s, the earliest depiction to which a date can be attributed is the "Plan de Louisbourg, 1723/1724,"[9] thus establishing that the project originated with Verville. It was first referred to specifically by Verrier in some of his earliest correspondence, when he wrote of the "galerie sur la ligne capitale" being almost entirely covered[10] and was well illustrated in his 1725 plan (Fig. 115). The provisional *toisés* of 1727 remove all doubt. It was a "galerie de mines" with "fourneaux" (mine chambers to receive charges of gunpowder) set in the three points of the cross beneath the glacis. Built of masonry, it was calculated to be 26 *toises* (50.7 m) long, each branch being 6 *toises* long (11.7 m), 1 *toise* 2 *pieds* (2.6 m) wide and 4 *pieds* 9 *pouces* (1.55 m) high to the spring of the arch.[11] Commonplace in Europe, where the numerous fortified towns with elaborate outworks lent themselves to such preparations, mine galleries were, by the nature of North American fortifications, rarely constructed.

Low-lying in comparison with the main *enceinte* and presenting primarily an earth slope to attackers, it is not surprising that the outworks suffered far less damage during the first siege than the defences they inadequately screened. However, they were not unscathed. The *batardeau* in front of the Dauphin Bastion was in serious disrepair, as both the British and returning French noted.[12] Completely exposed to artillery fire from batteries across the harbour, it must have received many direct hits. Elsewhere the poor condition of the outworks appears to have been due more to general deterioration and lack of maintenance than to enemy action. The counterscarp was said to be collapsing into the ditch, the glacis revetment collapsing onto the covered way, and the palisades in advanced decay.[13] Of less urgency than re-establishing the ramparts and parapets, repairs to the outworks had still not been undertaken when Franquet made his inspection in 1751, for he, too, deplored the general state of decrepitude. In addition, he noted that the whole salient area of the *place d'armes* in front of the King's-Queen's curtain, including its glacis, had sunk by more than 4 *pieds* into the bog and the traverses had deteriorated badly.[14]

The engineer also found grave shortcomings in the original design. The Queen's-Princess and King's-Dauphin fronts in particular were considered vulnerable, the one because of the commanding position of Black Rock, the other because the open expanse of pond left the curtain completely exposed, and Franquet could not fail to see the dangers presented by the low hills in front of the Dauphin Bastion. Everywhere the glacis was too low and too short. He proposed raising the crest -- and hence the revetment of the glacis -- and extending the slope to about twice its current length.

Of the various permutations of outworks envisaged, only one of his more modest proposals seemed assured of ministerial approval -- the construction of a *demi-lune* on each of the two most exposed fronts -- but even this project was reduced in scope. The Queen's-Princess front could be improved as proposed, but the other front was to be covered by a simpler work.[15] What was built on the King's-Dauphin front was an earthwork that Franquet referred to as a tenaille,[16] although neither in its location nor in its form did the work resemble any of the three basic types of tenaille designed by Vauban or anyone else (Fig. 97).[17] He basically continued the alignment of the counterscarp and covered way across the pond, a shallow re-entrant being formed in front of the curtain in a normal manner. The design was unusual in that no work occupied the re-entrant. One would usually expect to find a *demi-lune* at this location or, more modestly, the covered way would be enlarged to form a *place d'armes;* however, Verrier's design had provided two smaller, irregular *places d'armes*, one on each side of the re-entrant, because of the gap he left across the pond. Franquet retained this configuration so that the re-entrant, occurring to the left of centre in his new work, was in the pond and flanked by the existing *places d'armes*. The tenaille thus formed consisted of the whole area between the capital line of the *place d'armes* off the right shoulder of the King's Bastion and the capital line of the *place d'armes* off the left shoulder of the Dauphin Bastion. Franquet chose to apply the term "tenaille" solely to the new earthwork in the front because it completed the re-entrant sector of the covered way. Its principal contribution appears to have been as a dam across the pond, controlling the water level by means of a sluice-way and thus making attack all but impossible in this sector.[18]

While retaining the location of Verrier's *places d'armes*, Franquet modified considerably the design of the one off the left shoulder of the Dauphin (Fig. 97). His purpose was twofold. The new alignment of the revetment and banquette would provide better flanking fire along the tenaille face as far as the *place d'armes* on the far side of the pond, and, in conjunction with modifications of the glacis revetment, assured more efficient flanking fire along the glacis, giving better cover to the road through the outworks to the Dauphin Gate.[19] By enlarging the *place d'armes* in front of the flanked angle of the Dauphin Bastion and extending its banquette and revetment much closer to the beach -- a relatively simple operation -- the passage through the outworks was moved to the left of the salient angle of the glacis, where it was exposed to much greater fire-power from different locations along the covered way; formerly, being to the right of that salient, the passageway had been effectively masked by the glacis from all but the right face of the *place d'armes*.

More ambitious projects were approved for the other weak front. The *batardeau* in front of the Princess Bastion was relocated closer to the beach, thereby extending the ditch, and the ditch was increased in width to accommodate the transformation of the *place d'armes* in front of the Queen's-Princess curtain into a *demi-lune*. The extent of the project is clear in Franquet's plan (Fig. 100): the existing counterscarp and covered way in front of the right face of the Princess Bastion appears to have been left in place but a new section of ditch dug through the glacis parallel to the right face isolates the previous work, which Franquet then modified and referred to as a *contre-garde*.[20] Works thus described were usually built parallel to and in front of both faces of a bastion, joining to form an inverted V, but this was clearly impossible in the case of the Princess Bastion. Franquet could have more aptly applied the alternate term *couvre-face* as only one face of the bastion was in fact covered.

To the right of the *contre-garde*, more new sections of ditch were excavated to create two re-entrants with a salient between them. In each re-entrant the covered way was expanded to form a *place d'armes*, while the wide salient was occupied by the new *demi-lune*. The old *place d'armes* was simply covered by the new works (Fig. 208).

Despite the impression of neatness and solidarity conveyed by the plans, the *demi-lune* was a more rough-and-ready work than Franquet had intended. Begun in 1755 with the possibility of a British attack becoming ever more real, the builders were pressed to complete the work as quickly as possible, at the cost of foregoing a full revetment in sound masonry.[21] Indeed, the report on the state of the defences after the British had taken the town for the second time considered the *demi-lune* to have been unfinished, as well as poorly revetted with dry-stone walling that was falling apart because of the climate.[22]

For the outworks on the King's-Queen's Franquet felt less concern and proposed no major modifications, although the general state of disrepair and the way in which the *place d'armes* was sinking were serious enough. How much work was done on the counterscarp masonry and glacis revetment is not certain, but by 1758 the counterscarp at least was again in a sorry state, crumbling away in many places.[23] Franquet had managed to attend to his sinking *place d'armes*, which after much effort he had raised and set on timber cribbing (*pilotis*).[24]

How and to what extent the outworks were rendered ineffective by the British when the fortifications were reduced in 1760 is not clear since the written records deal exclusively with the firing of demolition charges in the ramparts.[25] Those responsible deemed it sufficient to knock down the crest of the glacis, and perhaps the revetment above banquette height, to remove the palisade posts, and perhaps to pry away the upper section of the counterscarp. The plan accompanying the demolition report included five profiles across the ramparts and outworks which, while lacking detail and probably impressionistic, uniformly show the obliteration of the counterscarp, covered way, revetment and crest of the glacis (Fig. 102). A note indicated that the demolition charges were placed wherever the work "could not be compassed by Pioneers only."

Prior to abandoning the area, the British carried out a small construction project which affected a portion of the outworks. Having so thoroughly demolished the fortifications, the garrison now found itself in the embarrassing situation of being defenceless should the French retaliate; thus on the salient of the glacis immediately opposite the flanked angle of the King's Bastion they erected a blockhouse. Little is known of this work, but it is depicted in the Thomas Wright view of 1766 and on the Sproule plan of 1767 (Figs. 199, 103). A ditch surrounded the blockhouse following a bastioned trace based on a square; presumably the earth removed during the excavation was thrown up as a low parapet. Communication with the town, in which some houses had survived and were being occupied by British troops or hopeful settlers, was established by a causeway across the ditch and over the ruined flanked angle of the King's Bastion. The access route thus created remained in use long after the garrison had departed. When in 1946 the Society for Colonial Wars erected a monument on the remains of the blockhouse, the road which Kennelly had begun in the 1900s and which was later extended to the museum building in the 1930s now continued across the left wing of the barracks and bastion terreplein, exiting at the flanked angle along the old British causeway. The state of the outworks and the effects of the various intrusions prior to the current programme were clearly visible from the air (Fig. 110).

The outworks were not excavated in their entirety during the archeological investigations, which were limited to the two fronts destined for reconstruction. The technically more interesting Queen's-Princess front, incorporating Franquet's *demi-lune* and *contre-garde*, remains untouched except for gravel access roads, nor has his *tenaille* been examined in detail, since to do so would have blocked what was then the main construction access to the site. (With a portion of the town and defences being re-built to its condition in 1744/45, the *tenaille* would be an anachronism and so has not restored.)

As part of the excavation of the Dauphin ditch (see "The Dauphin Half-Bastion"), the *batardeau* was investigated. Somewhat unexpectedly, despite the overall appearance of the area and the presence of a concrete culvert beneath the modern road, the foundations and several courses of the *batardeau* were located spanning the entire width of the ditch -- there measured as 15.4 m. The documentation had indicated that the *batardeau*, having sustained severe damage during the first siege, had been extensively repaired; the occupying forces from New England had begun the work but not finished it. The excavated remains certainly lent credence to such a sequence. The ashlar facing consisted of dressed sandstone finished in a manner common to the great majority of dressed-stone features throughout the fortress, but in addition several stones with a distinctively different finish -- characterized by broad, parallel chisel cuts -- were present, predominantly on the seaward side. The ashlar revetment continued beyond the *batardeau* and along the quay wall beneath the officer's guardhouse to the right of the gate. The provenience of such stones, limited to the Dauphin Bastion, is taken to indicate British work during the 1745-49 occupation (see "The Dauphin Half-Bastion: Ramparts; Officer's Guardhouses").

Further signs of repair were apparent. Timber uprights, rectangular in cross-section (21.6 x 24.4 cm) and spaced at intervals of 1.37 m, were set in the seaward façade of the *batardeau* and continued along the quay (Fig. 220). To these were nailed horizontal planks which entirely sheathed the masonry in a manner already encountered on the escarps. It is not clear when this work was carried out or by whom. As the British had repaired the wall prior to their departure according to their own accounts, and as Boucher on his first tour of inspection upon returning in 1749 noted that the exterior section on the side facing the sea was revetted in heavy planks as it was formerly,[26] we may assume that the British had indeed installed planking here. But had the wall been so treated prior to 1745, as Boucher's text implied? Plank revetting was becoming a generally applied solution to the problem of masonry deterioration, while in the case of the quay wall it appears to have been applied from the outset (see below). On the other hand, Franquet's comments as to the ruined condition of the *batardeau*[27] and his statement that he had rebuilt it in 1755[28] suggest continued construction activity in the area. Attribution of the *in situ* remains to a particular phase is not possible.

Comparison of the pre-1745 plans, in particular Verrier's 1733 elevation of the gate showing the *batardeau* in section, with Franquet's 1756 section across the rampart and ditch, which shows the *batardeau* in elevation, suggests that little change was made to the basic structure. Boucher's estimates for rebuilding it[29] correspond well with the dimensions of what was found: 8 *toises* (15.6 m) for the length, as opposed to an actual measurement in the field of 15.4 m, and an average width of 1 *toise* 1 *pied* 6 *pouces* (2.44 m). The base measured 2.82 m in width. Considering that Boucher's dimension was an average for the wall that tapered considerably from bottom to top, as Verrier's section shows, then the lesser figure of 2.44 m is acceptable. Verrier's section shows an inner core of brick enveloped in rubble-stone and faced in ashlar; the section observed in the field was identical but for the addition of the exterior planking. There is a similar correspondence between the 3-*pied*-wide (97 cm) wooden frame for the sluice estimated by Boucher[30] and the plank-lined, timber-framed channel, with an average width of 96 cm, that was found (Fig. 193). A recess in the side walls of the sluice and a gap in the plank flooring were presumably designed to accommodate the sluice-gate itself, which would have been raised or lowered by operating a simple mechanism from above. Such a device is suggested in pre-construction plan and profile (Fig. 161), but nothing is shown in the demonstrably more reliable section through the *batardeau* (Fig. 167). Franquet's 1756 drawing also indicates a vertically operated sluice-gate, but with no real detail; however, two right-angled timber braces found in the ditch just in front of the sluice may be supports for the mechanism or the platform on which the operator stood.

No close correlation existed between the pre-1745 plans and the *in situ* remains, particularly insofar as the length of the *batardeau* is concerned. While no actual measurements are given, the scaled length varies considerably from plan to plan, 10 *toises* (as opposed to Boucher's 8 *toises*) being the most common, even on the post-construction plans (i.e. post-1731). A discrepancy of 2 *toises* (3.9 m) is significant for the interpretation of not only the *batardeau* but also the width of the ditch and consequently the whole of the outworks. Could the *batardeau* have been rebuilt appreciably shorter, thereby entailing the realignment of the counterscarp and covered way, which were also described as being in poor condition? The counterscarp proved to have been extensively repaired. Reused dressed sandstone blocks were frequently encountered, while the short section immediately opposite the gate was, like the exterior of the *batardeau* and the escarps of the bastion itself, revetted with wooden planking.

Yet nothing indicated any change in the alignment of the counterscarp. The covered way rested on undisturbed natural soil, the original hillside having been levelled to expose the iron-enriched B horizon or even the underlying horizon; the counterscarp had been built directly against the side of the bank left by the excavation of the ditch. In one trench, signs of intrusion behind the counterscarp were evident and may have been caused by post-construction repair work since initially there would have been no need to dig a foundation trench (Fig. 175). Nowhere, however, was the natural soil disturbed on the covered way itself, ruling out any possibility that the counterscarp could have been originally on an alignment forward of its location when excavated archaeologically. The assumption that the width of the ditch was as indicated on most of the historical plans must be dismissed, and with it any reliance on the overall accuracy of those plans.

In spite of subsequent repairs, the alignment of the counterscarp was thus considered to be as originally constructed. On the other side of the covered way, the glacis revetment was similarly found to be unchanged; indeed, in the surviving courses of masonry no alterations could be detected. Where the banquette could be observed in section, disturbance against the revetment was suggestive of trenching in order to plant (or remove) palisades, but no rebuilding or realigning of the wall itself was apparent. In fact, the covered way revealed was substantially the one Verrier built and conforms to the plan Franquet drew in 1751 prior to his undertaking any work (Fig. 87). This may appear to cast doubt on Franquet's credibility, for the documentary evidence -- largely in the form of correspondence and plans by the engineer himself -- points to definite changes, particularly in the *places d'armes* off the left shoulder of the bastion and in front of the flanked angle. But even the documentary sources can allow us to deduce that Franquet's structures were not as regular and solid as his drawings might suggest. In the case of the *place d'armes* in front of the flanked angle, few conclusions may be drawn because much of the area has now been eroded by the sea and the rest obliterated by the modern road (see Figs. 98, 110, 171). Of the passageway through the glacis, which originally must have had masonry retaining walls on each side, only a few courses of the landward side and its junction with the revetment of the covered way were found beneath the surface of the road. All associated earthworks had been levelled.

The *place d'armes* off the left shoulder of the bastion, in contrast, had survived in much better condition and conformed in general appearance (Fig. 171) to Franquet's modified version. The original revetment had survived, but the upper courses had been removed and brought in to raise the terreplein level of the modified work (Fig. 176), but of the new revetment there was no trace beyond the contouring of the present-day surface. Although the project had been carried out, the revised *place d'armes* must have been very like a field fortification, employing no masonry, although this is by no means clear from Franquet's plan.

Two further discrepancies between the plan and what was found should be noted. Communication between the original covered way and the modified *place d'armes* in front of the flanked angle appears to have been established by cutting through the revetment just to the right of the salient of the original *place d'armes* according to Franquet's 1756 plan (Fig. 97), yet no break was found in the wall even though it had survived to sufficient height that such a feature should have been apparent. Secondly, no trace of the traverses indicated on the plans (two on the 1756 plan [Fig. 97], three on the 1758 plan [Fig. 101]) was found. Where these, too, insubstantial earthworks not surviving in the archaeological record or had they never existed? Traverses elsewhere were unambiguously present in the form of solid, masonry-revetted structures.

Where the counterscarp terminated at the edge of the pond, the angle formed between the counterscarp and the left face of the *place d'armes* was constructed of dressed sandstone quoins, carefully cut and laid with a slight batter so at to ensure maximum stability. Located directly against the wall at this point was the well-preserved plank revetting of Franquet's tenaille (Fig. 197). No further examination of the tenaille was conducted.

On the far side of the pond, in front of the King's Bastion, the counterscarp continued its interrupted course. The end on the pond was retained by a wall extending the width of the covered way, and the angle was carefully finished with sandstone quoins which had survived to almost the full height of the counterscarp. There the counterscarp was at one of its highest points because the ground was comparatively low-lying; as the terrain rose towards the flanked angle of the King's Bastion, the counterscarp height diminished somewhat.

Thus the wall near the edge of the pond would originally have been 4 m high and the salient, 2.7 m high. These dimensions represented the depth of the ditch, which was shallowest where the original land surface was at its highest and where outcrops of bedrock were incorporated in the foundations. Such adjustments to local conditions nevertheless failed to produce a covered way at a constant elevation: the ground rose too steeply. In the areas opposite the left and right shoulders of the bastion, the covered way was appreciably lower than at the salient, but there was no real symmetry to the differences in elevation. The highest point was in fact not at the salient itself but some 36 m to the right, where an elevation of 11.82 m was recorded. To the right again, the covered way sloped slightly toward the pond, where it ended at an elevation of 5.3 m. To the left an even more gradual slope to the salient continued down along the left face to an elevation of 10.36 m off the left shoulder. Some 18 m farther on, where the covered way expanded into the *place d'armes*, it was at an elevation of no more than 9.1 m, at which level it remained within the limits of the excavated area except in the area surrounding the steps from the ditch to the *place d'armes* where it was 76 cm lower than elsewhere (see below).

In many of the sections excavated across the covered way, natural soil horizons were observed. In the higher areas (i.e. off the right face of the King's Bastion), it was apparent that the old land surface had been used as the surface of the covered way without modification. Similarly the glacis revetment was set directly on the old surface with little or no excavation for the foundation, which was at roughly the same elevation as the covered way. The significance of this in terms of the glacis will be readily apparent: was the top of the revetment -- and hence the crest of the glacis -- built parallel to the base, or was it raised to a constant height? Maintaining the revetment at a uniform height (ideally, 4-1/2 *pieds)* would have provided adequate cover and a parapet over which defenders could fire; however, the glacis, like the covered way, would then have been lower toward the shoulders of the bastion than in front of the flanked angle. The alternative -- raising the glacis in order to provide adequate cover for the full length of the bastion faces -- would have varied the height of the covered-way revetment. It is likely that a completely satisfactory situation was never realized although a compromise between the two alternatives seems to have been attempted. The banquette was not always discernible in section, but where its horizontal surface could be distinguished, its height above the covered way was within centimetres the same everywhere -- 97 cm (approximately 3 *pieds)* -- suggesting that a reasonably uniform parapet height had been considered desirable. The crest of the glacis had nowhere survived, so its location could only be deduced by prolonging the slope of the glacis. As discussed earlier ("The King's Bastion: Parapets"), the degree of slope varied considerably, being steepest in front of the right face. The calculated height of the crest varied from a low of 1.34 m to a high of 1.5 m; the ideal parapet height of 4-1/2 *pieds* (1.46 m) lies between these extremes.

The glacis was disturbed in several areas, but the incorporation of the natural hillside in front of the King's Bastion resulted in an uneven slope and irregular alignment of the foot of the glacis. It clearly fulfilled the requirement of providing an open, exposed slope to the enemy more effectively than that of screening the ramparts to the rear (Fig. 217).

The above argument holds good primarily in the case of the glacis in front of the King's Bastion. The work in front of the Dauphin Bastion was deemed inadequate, less because of problems of terrain than because it had never been raised to its proper height. It is only when the King's-Queen's front is examined that we are able to perceive anything approaching an acceptable norm. The area is practically level, the foot of the glacis is straight and well defined and the slopes are regular. Franquet nevertheless considered the outworks here, as everywhere, too low -- quite apart from the problems of subsidence.

The covered way was expanded into two *places d'armes*, one on each side of the capital line of the King's Bastion. To the right, the regular trace could not be observed because of the pond and the sloping ground, so that the *place d'armes* was located much closer to the right shoulder angle of the King's Bastion -- a natural complement to the work in front of the left shoulder of the Dauphin Bastion. The way in which the ground sloped down to the country in front and to the pond on the right dictated the narrow, tapering outline terminating in a rounded salient; furthermore, being on a slope, the right side of the work was lower than the left by

1.25 m and offered inadequate cover against reverse fire (see "The King's Bastion: Ramparts"). Excavation confirmed the overall plan of the *place d'armes* and the presence of a banquette on both faces, but revealed no evidence of any repairs or modification to the original design.

The *place d'armes* in the re-entrant in front of the King's-Queen's curtain was built on much more level ground and was, as a result, a regular work on each side of its capital line and had no significant change in elevation throughout; the greatest variations occurred along each face. A drop of 83 cm along the right face and 55 cm along the left were recorded. The area was not without its problems, but the slight change in elevation does not accord with the description of a feature that had sunk by 3-1/2 *pieds* (1.14 m) and as much as 4 *pieds* (1.3 m) at the salient.

Excavation revealed that the elevation of the swamp at the foot of the glacis was at the same level as the base of the masonry revetment at the salient (7.92 m above sea level), demonstrating that the *place d'armes* had been built directly on a peat bog. Small wonder that it sank; however, the revetments of the faces rested on timber beams and planks which provided a wider, firmer footing in the soft ground. This was a recognized and approved practice in such terrain,[31] and one to which Franquet specifically alluded. In section, two levels of banquette were observed against the revetment. These observations provide conclusive evidence of extensive rebuilding of virtually the entire work.

The terrain was not uniformly boggy. In the gorge of the *place d'armes*, especially where it rejoined the covered way to the left, outcrops of bedrock were located at terreplein level, where they had been roughly levelled by the builders. In one instance, the vertical surface of the bedrock was incorporated into the face of the counterscarp and its upper, horizontal surface into the terreplein of the covered way. Verrier's dismay on encountering such difficult conditions when excavating the ditch has already been noted (see "Curtain Walls").

The best evidence for traverses on the covered way came from this area. Where the faces of the *place d'armes* rejoined the covered way, the revetment contained an offset (*crochet*) to allow a traverse to occupy the full width of the covered way, at the same time maintaining an unobstructed passage around the end. The traverses were well-constructed masonry rectangles containing earth fill. Built on the counterscarp, both east walls were vertical extensions of the counterscarp. The presence of reused dressed sandstone to form the quoins of the traverses suggests that they, too, received attention under Franquet's repair programme.

No archaeological evidence pertaining to the original height of the traverses was forthcoming. On the basis of surviving examples in France (Fig. 218), the highest point would have been at or slightly below the height of the adjacent crest of the glacis, with the upper surface sloped like a parapet towards the covered way (facing outwards from the *place d'armes*) which the defenders could enfilade while being protected themselves. The traverses would require banquettes to enable troops to fire over the crest, but while such features are suggested in various plans (Figs. 99, 100), no positive identification could be made in the field.

Examination of the features associated with communication to the outworks revealed few surprises. A close correlation between what was found and the demonstrably more reliable plans -- particularly the overall plans Verrier drew in 1744 and Franquet in 1758 (Figs. 84, 101) -- was observed. In the area of the Dauphin Bastion, access to the covered way was either via the main gate and across the drawbridge or via the postern tunnel and across a narrow wooden footbridge. A few traces of timbers presumed to have come from the footbridge and its supports were located in the mud in front of the postern tunnel entrance.

Recessed in the counterscarp, the single set of steps leading to the *place d'armes* off the right shoulder of the King's Bastion was located but unfortunately destroyed by the installation of a waterline before it could be recorded. The double set of steps, similarly recessed in the counterscarp, leading to the covered way to right and left of the salient angle opposite the flanked angle fared somewhat better. The British causeway of the 1760s had filled the ditch at the salient, obscuring and preserving the steps virtually intact. The mine gallery entrance was also well preserved, its dressed-stone jambs complete with wrought-iron pintles, and the gallery itself was still intact (Fig. 216).

Leading to the left re-entrant *place d'armes* was yet another double set of steps, the southern set being well preserved for several courses (Fig. 204). Some of the missing steps appear to have been reused as quoins in the nearby traverses. Cut with a slight batter of one in twelve, which presumably conformed to the batter of the counterscarp, each step had been identified by its cutter with sequential Roman numerals, and stones with identical batter and Roman numerals were found in the traverses.

The lower steps must have become useless some time after completion of the ditch, for the low-lying, swampy terrain drained into the catch-basin Verrier had created. The wooden bridge leading from the postern opposite rested on the third step up from the bottom of the ditch. The bridge itself, found in the mud at the bottom of the pond, was particularly well preserved and yielded details of the "saw-horse" supports and plank decking.

Communication from the outworks to the country was somewhat restricted. On the two fronts examined in detail were only two exit points, one in front of the Dauphin Gate, the other in the *place d'armes* in front of the King's-Queen's curtain. The former was where the main road into the town passed through the glacis, and therefore had to be wide enough to permit passage of wheeled vehicles. Little is known of the feature beyond what is indicated on the historical plans: a straight passageway, revetted on both sides with masonry walls, a constriction at the intersection with the revetment on the covered way, and a slight flare as it opened onto the covered way in front of the bridge and gate. Judging from the plans, the passageway through the glacis would have been about as wide as the fixed portion of the bridge across the ditch (ca. 5 m).

Most of the area has been either eroded by the sea or removed by 1930s road construction, but the junction between the passage wall and the covered-way revetment had survived. The constriction of the passage and its subsequent widening on the covered way, delineated by a a short wall which would have retained the end of the banquette, could be observed. In the offset created by the constricted entrance no indications were found of a masonry column to support a gate, as might have been expected. Instead, a decomposed wooden post, 10 x 15 cm in cross-section, as all that was found, evoking the image more of a farm gate than the main entrance, albeit only on the outworks, to a walled town. No form of a gate with pillars is depicted on any plan or view.

In contrast, the other passage, through the right face of the King's-Queen's *place d'armes*, served a strictly military function to allow soldiers to make a surprise sortie against a besieging force. It was considerably wider at the foot of the glacis than where it passed through the covered-way revetment: 5.25 m as opposed to 1.89 m. The sides of the passage were not masonry-revetted for their entire length: at the foot of the glacis the walls were continued with palisade posts. Exactly where the change between masonry and wood occurred could not be determined because a service road cut across the passageway near the foot of the glacis (Fig. 201), nor is any reasonable interpretation apparent for the use of palisades.

Beneath the retaining walls, timber cribbing indicated that this area, too, had been repaired by Franquet.

The constricted entrance did yield evidence as to how it could be barred. On each side of the entrance, jambs of dressed sandstone were bonded into the junction between the covered-way revetment and retaining walls of the passage and were rabetted to accommodate an outward-opening door. A stone cut to receive a pintle was found in its original place to the right of the entrance, thus demonstrating which way the gate would have swung.[32] A similar jamb stone, found in the rubble blocking the passage, was cut to receive an inverted pintle. Once in place, the gate, with large strap hinges securely rivetted to it, could not be simply lifted up and off its pintles as would be the case if the upper pintle, like the lower, pointed skywards: an ingenious precaution against a surprise attack.

A row of palisades was planted in the banquette as an added obstacle to troops storming the glacis. A favourite defensive device in one form or another, the palisade was, at its simplest, a row of sharpened poles projecting above the crest of the glacis, attached to ribbands in short sections.[33] It was regarded as a permanent component of the outer perimeter, not just a last-minute addition in time of impending attack, as the frequent references to completing its installation in the late 1730s and early 1740s attest. However, this was not without its drawbacks, as equally frequent references to decaying posts and the need to replace them demonstrate. The engineers appear to have been unable to locate adequate supplies of the species of wood least susceptible to rotting when embedded in soil. In 1751 Franquet enigmatically stipulated *prusse* since oak was not likely to be found, and further recommended charring the ends to go in the ground as a means of inhibiting rot;[34] a year later, however, he was complaining about the lack of cedar -- also renowned for its resistance to rot -- and resigning himself to spruce and hemlock.[35] Traces of the trench in the banquette into which the palisade was set were located in all excavated sectors of the covered way and fragments of palisade posts were occasionally recovered. Significantly, the only samples capable of analysis proved to be of spruce or balsam; none of the better but rarer species was found.

The best-preserved sections of banquette, complete with post-holes, were on the townside *place d'armes* (Fig. 159); however, the disposition must have been very much the same as on the landward defences and can confidently be extrapolated. Round posts, between 9 and 15 cm in diameter, located roughly 30 cm from the covered-way revetment and closely spaced to each other, were embedded to the full depth of the banquette. From both Franquet's specifications and secondary sources it is apparent that the pointed tips of the palisades hardly projected at all above the crest of the glacis, so that they would not be easily demolished by artillery fire. Their potential as an obstacle would appear to be negligible, especially when viewed from the foot of the glacis, and it is only when trying to climb over them and jump down onto the covered way that their value is appreciated. It can be done, but slowly and carefully -- not the way to approach a hotly contested area fully exposed to fire from the ramparts.

Essentially, with the exception of the *demi-lune* and *contre-garde* on the Queen's-Princess front, the more ambitious proposals for advanced works remained just that -- proposals deemed too costly or otherwise unjustifiable. However, faced with the imminent danger of an attack, Franquet improvised additional works which may conveniently be grouped with the other outworks. The King's Bastion was of major concern. In spite of major repairs, the escarps were in poor condition; the crumbling left flank was protected with a mass of fascines and turf (see "The King's Bastion: Ramparts"), while the right flank, although solidly rebuilt, was perilously exposed. As a means of protecting the right flank and re-entrant area, Franquet caused three works to be built in the ditch. Two were large traverses close to the re-entrant angle and the third, covering the right shoulder and extending across the ditch almost to the counterscarp, appeared almost like an isolated section of glacis[36] (Figs. 101, 219). The side nearest the flank was revetted in masonry, supporting a slope which diminished towards the Dauphin Bastion. Another, somewhat smaller traverse was built off the left shoulder of the bastion, and a palisade parallel to the faces was set in the centre of the ditch from the right shoulder to well beyond the left shoulder. In addition, the *place d'armes* in front of the King's-Queen's curtain was retrenched and palisaded, and, finally, a zigzag line of retrenchments was extended from the glacis in front of the *demi-lune* as far as the shoreline southwest of Black Rock, thus covering the commanding point of ground on which a redoubt or at least a battery should have been placed according to Franquet and others. The disposition of the various *ad hoc* works is clearly depicted on the 1758 plan (Fig. 101).

Excavations exposed the three works off the right flank of the King's Bastion. In spite of the haste with which they had been built, the dry-stone revetting was carefully laid. The longest of them, overlying a drain flowing from the right flank, even had a drainage channel with dry-stone sides and plank capping beneath its glacis. These features were deliberately removed during the present programme because their date of construction (1757) did not accord with the date to which the fortress was being restored (1744-45).[37]

The remaining traverse in the ditch, located off the left shoulder, was mistakenly removed as insignificant rubble at an early stage in the current work, and thus only partially recorded. Of the palisade parallel to the faces of the bastion, nothing was observed *in situ*, but when the pond in front of the King's-Queen's curtain was cleared, two well-preserved fragments of what were clearly palisade posts were recovered; the defensive line in the ditch is the most likely attribution.

During the excavation of the King's-Queen's *place d'armes*, a sector in the gorge around the steps was seen to be lower than elsewhere on the covered way. No palisades or other features were identified, but the lowering of this area may have been associated with the construction of the retrenchment Franquet ordered in 1758.

The line dug beyond the glacis to isolate Black Rock has not been investigated archaeologically, but its course is clearly visible today as a slight depression paralleled by a low mound of rubble.

La Nouvelle Enceinte

Before the landward defences had been completed, work began on a new line of fortifications facing Rochefort Point. The immediate events leading up to the new line were Verrier's proposals on guarding the shallows in front of the Princess Bastion and St. Ovide's concern that these would not be enough to prevent a landing in force (see "Completion of the Landward *Enceinte*").

As early as 1730, Verrier had made provision for a defensive wall extending along the shore from the Princess Bastion all the way around Rochefort Point, where a battery would be located (Fig. 73). This was suspiciously like the concept St. Ovide favoured in 1736, but in the intervening years there had been no discussion of the project and it was not represented on any other plans. Instead, the engineer simply suggested a projecting spur or *éperon* at the Princess Bastion to inhibit troop movement along the shore. Ministerial rejection of Verrier's proposed *éperon*, however, was not to be taken as approval of St. Ovide's concept. It was made very clear that governor, engineer and *ordonnateur* should reach a mutually acceptable solution at the least cost to the Crown so the minister could obtain royal approval without having to assess conflicting recommendations.[1]

The desired proposition was rapidly forthcoming, as illustrated by Verrier's plan and profiles submitted in 1737 (Figs. 78-80). The fortifications would consist of "un front Remparé" of two bastions, the one to the left flanking a harbour battery to which it would be connected by a line of posts set in the pond that lay between them.

Past construction experience would be drawn upon to counteract the detrimental effects of climate: "it is calculated that in order to preserve [the walls], it is necessary to revet them with planks two *pouces* thick which will be held in place and nailed to pieces of wood anchored in the masonry...."[2] (Author's translation.)

While conceding that St. Ovide's concern was valid, the engineer reiterated that it would be preferable to complete the landward defences prior to embarking on any new programme,[3] but in this he was also overruled. Perhaps lulled by Verrier's repeated assurances that only minor work was needed to complete the old *enceinte*, the minister instructed that the new work should begin straight away "so that the town may finally be secure on all sides."[4] (Author's translation.)

While no specific allusion to any changes in plan is made in the documentation, a comparison of the plan and profiles of the original 1737 submission (Figs. 78, 79, 80) with their equivalents for 1741 (Figs. 82, 83) reveal several significant changes in detail. In the absence of archaeological investigation, the later drawings, purporting to be records of work actually carried out or in progress, must be assumed the more reliable.

Neither of the two bastions were completely regular works. The one to the left, named Maurepas Bastion in honour of the minister, appears as the more conventional, but was not symmetrical to left and right of its capital line. One of the 1737 plans (Fig. 79) shows, on a fold-out attachment, a proposed cavalier in the left shoulder angle, but it no longer appears in the later plans. Instead, on the 1741 plan the left face has the potential of being a powerful battery, furnished as it is with gun embrasures along its entire length. The obvious intent, was to command the shallows off Rochefort Point, the harbour approaches to Battery Island, and the main channel into the harbour itself. The left flank was intended to cover the line of posts which served as a curtain across the pond and the battery located on the beach, referred to appropriately enough as "Pièce de la Grave." The battery, too, underwent considerable changes as construction progressed, represented at first as a simple rectangular rampart fronted by a ditch, counterscarp and glacis, and gradually evolving into a powerful extended work capable of firing over a wide arc (Fig. 224).

Perhaps one of the most inexplicable features of Verrier's design is the front between the flanked angles of the Maurepas Bastion and the adjacent Brouillan Bastion, named in honour of the governor of the town. On the 1741 plan, the right and left flanks of the respective bastions join the curtain at right angles. Such a trace had been out of favour with military engineers for the better part of a century, inadequate as it was for providing flanking fire along the faces of the opposing bastions, yet the design evoked no comment from either the minister or, later, Franquet. There is no readily apparent reason why Verrier should have reverted to such a demonstrably unsatisfactory disposition, especially as the 1737 design was more conventional. Later plans are not entirely consistent and excavation would be required to determine the actual angles.

The Maurepas Bastion, built as it was in the pond, had the unusual distinction of being entirely flooded inside. It consisted, in effect, of ramparts rising like dykes out of the water, similar to works in the Low Countries. The ramparts themselves were conventional, although the same could not be said for those of the Brouillan Bastion. Although its right face and flank conformed to the bastion trace, these walls were in reality a continuation of the "mur crénelé" that extended across the beach to the Princess Bastion. This was as originally intended, but comparison of the 1737 and 1741 plans again reveals slight modifications: the gorge of the bastion is larger on the later plan and hence the flanked angle is wider, the face is advanced further onto the beach, and the work appears more regular in trace.

In the profiles of the front several differences are also apparent. Verrier intended to encase the escarps in plank right from the beginning, but the appearance of the escarps on the 1737 profiles is nevertheless conventional -- a wall that is vertical on the interior, has a batter on the exterior, and is surmounted by a parapet with a vertical exterior revetment. The treatment of the parapet reveals that experience had taught him to rely on a thick cover of turf: the masonry revetment is quite low (3-1/2 *pieds*) and the exterior crest built up approximately 2 *pieds* in turf.

The 1741 profiles are considerably different. The escarps lean inward with parallel interior and exterior surfaces. Such a design only makes sense in exceptional circumstances as may be encountered when the side of a hill is pared away to become the rampart itself and is simply stabilized with a masonry facing. Rochefort Point is low-lying and gives little indication that such conditions would have obtained prior to construction of the new fortifications; the only indication of any knolls is along the point's south shore, in front of where the Brouillan Bastion would stand (Fig. 67).

Verrier appears to have encountered extraordinary difficulties in preparing the ground and particularly in excavating the ditch. Rock that could only be removed by blasting was adding to the expense of the work and causing delays, he reported at the end of the 1740 construction season, although he felt that he could complete the Pièce de la Grave, the Maurepas Bastion and the covered way the following year.[5] He was too optimistic. A dozen miners had to be employed to continue blasting operations in the summer of 1741[6] and it became obvious that the completion date would have to be postponed to the next year.[7] The following August, in spite of progress on the parapets, embrasures, covered way and glacis, blasting was still being carried out[8] and it was not until November that Verrier finally wrote:

> I make so bold as to assure your Lordship that the fortifications of Louisbourg are completed in their entirety, the town enclosed on all sides and the garrison in a good state of defence if munitions and food are not in short supply, and additional regular troops are sent out.[9] (Author's translation.)

The modification had clearly taken place as work progressed, and the nature of the terrain must have caused Verrier to use leaning revetments; however, his reports indicate that rampart fill was being deposited behind the escarps -- indeed, the lack of earth required material to be brought in from elsewhere. The original terrain was therefore not high enough to permit ideal application of the leaning-revetment method; reference to Belidor indicates alternative methods which would perhaps have been suitable.[10] The 1741 profile does not reveal to what extent the rampart behind the escarp was natural hillside, whereas there is little difficulty distinguishing the natural level in the area of the covered way and glacis, where the ground had in some instances to be lowered. Assuming that the darker lines (brown on the original coloured drawing) indicate the natural ground rather than a stage of progress in terracing the rampart, we can more readily understand further modifications to the 1737 profile. The total height of the escarp including foundation was less than originally proposed -- 17 *pieds* as opposed to 20 *pieds*, as near as can be judged by scaling -- there was no separate, vertical exterior revetment for the parapet, and the parapet itself, all in turf and earth, was correspondingly deeper.

The Pièce de la Grave appears to have been built on less stable ground, necessitating massive timber pilings and crib work. Its escarp was more conventional, although it, too, is shown with a parapet continuous with the exterior batter of the escarp.

Set in the curtain midway between the two bastions was an elaborate gate, also named in honur of the minister, who perhaps was flattered into approving such an unjustifiably extravagant and totally useless work. The gate also underwent changes in concept, to judge from an earlier drawing[11] and those included in the 1741 submission (Fig. 83), but lost nothing in the process. What Verrier had not achieved at the Dauphin Gate, he obviously intended to compensate for here. A full guardhouse was placed over the archway, equipped with a loopholed façade corbelled over the entrance and surmounted by an attic bearing the royal coast of arms. An inscription in gold lettering on black marble commemorated its joint dedication to the king and his minister.[12] As was customary, the entrance was flanked by guardhouses on the townside, and gave onto a bridge leading to the outworks. Communication could be severed by a drawbridge which, by the appearance of the lower chamber and the absence of overhead swipe-beams, was similar in design to the one at the Queen's Gate.

The only shortcoming was that the gate led nowhere. The few properties that had been developed on the point were now beyond the walls and were abandoned; the area's principal use was as a cemetery when disease decimated the New England troops in 1746.[13] A later minister was less impressed and saw little value to the gate or indeed the design of the whole front,[14] and certainly Franquet did not share Verrier's extravagant tastes, having more pressing problems elsewhere.

Whatever the merits of their design and location, the new fortifications withstood better than most the ravages of climate and siege. Boucher attributed their state of preservation to the use of plank revetting as part of the original construction, but as most of the artillery fire had been concentrated on the King's and Dauphin bastions, little actual siege damage occurred in this area. He did note that several courses of masonry in the Maurepas Gate had been shattered by ricocheting cannonballs.[15]

Franquet also found little that needed to be done with the defences in this area and contented himself with minor adjustments to parapet height and slope.[16] However, the Pièce de la Grave, which he regarded as a well-situated, valuable work, was being covered by beach gravel swept against it by the currents eddying around the point, a situation that should be rectified by raising the ramparts, digging out the gravel and adding a breakwater[17] (Fig. 221).

Like the rest of the fortifications, the Rochefort Point defences were mined as part of the 1760 demolition programme. Since then, coastal erosion had taken its toll of the "mur crénelé" between the Princess and Brouillan bastions, as well as encroaching upon the most exposed elements of these two works. The Pièce de la Grave has likewise suffered, much of it surviving now only as timber cribbing visible during extremely low tides (Fig. 222).

The Quay

The waterfront area had attracted fishermen before Louisbourg was thought of and it inevitably became the focal point of settlement before the formal plan of the town was laid out (Figs. 65, 67, 69-70). The gravel strand along the sheltered harbour-side of the promontory was ideally suited to landing and drying fish;[18] however, as the town developed, fishing activities were relegated to the shoreline outside the walls, the area within becoming a place where materials and supplies were brought into the town. The intent to provide a proper quay dates to the same time that Verville received his instructions to proceed with the town plan and its fortifications. He was told to reserve a zone 10 *toises* (19.5 m) wide behind the high-tide line as its future location,[19] but the quay is not identified as such on plans prior to the one on which Verville shows the street alignments in 1722, and no detailed proposals were made.[20]

If the quay owed its origins to commercial interests, in its design military considerations were of at least equal importance. The project was Verrier's, envisaged first in the 1730s but not put into effect -- after many modifications -- until after the Rochefort Point defences were nearly finished. By joining the Pièce de la Grave to the *batardeau* of the Dauphin Bastion, the plan to enclose the town was complete.

As first conceived, the quay wall was generally to follow the existing shoreline, with a large centre section parallel to the east-west street alignment of the town, creating, in effect, an extended tenaille front. Two triangular redans (*redents*) were to provide flanking fire and near the Grand Etang -- where the Pièce de la Grave was eventually constructed -- a jetty or mole would serve as protection against high seas (Fig. 74). The defensive aspect, evident in the inclusion of the redans, was emphasized from the beginning by Verrier, who wished to guard against surprise landings by providing for adequate musketry fire along the face of the wall.[21]

As eventually constructed, the quay differed considerably in detail from the initial proposals although the overall concept of a front flanked on either side still remained. The evolution may be traced in a series of plans from 1737 to 1744 (Figs. 79, 82, 83, 84, 223, 224). The mole and centre redan disappear, the "redent de la Porte Dauphine" is transformed into a more compact projecting battery, now referred to as an *éperon*, and short flanks with gun embrasures are included at each extremity of the central curtain, thus basing the defensive fire on artillery rather than musketry.

Construction did not begin until 1741, by which time the work on the Rochefort Point defences were virtually complete and Verrier felt sufficiently optimistic to prepare estimates for the next construction project.[22] Beginning with extending the wall of the Pièce de la Grave, the work progressed rapidly in spite of the problems of founding a masonry revetment on the beach between high and low tides. By the summer of 1742 the wall had been completed to a height of 9 *pieds* (2.92 m) and was within 60 *toises* (117 m) of joining the *éperon* of the Dauphin Bastion.[23] A section drawn the following year clearly indicates the construction techniques used: timber cribbing to support the masonry load in the unstable ground, earth banked behind the wall, and plank sheathing placed on front, the nailers held in place by wrought-iron braces (Fig. 225). The upper portion of the wall was formed as a parapet, with a wide banquette behind it, once again highlighting the importance attached to the military aspect of the quay. As depicted, the wall stood some 12 *pieds* high above its foundation and was 6 *pieds* thick; the parapet above was a further 5 or 6 *pieds* high, but only 4 *pieds* thick. The full height of the wall was diminished by the accumulation of gravel swept in by the tide. This was an acute problem, especially at the re-entrant angles, as Franquet later pointed out.[24] Indeed, the major defect of the quay, militarily speaking, was that it was too low, and Franquet proposed raising it to a total height of 20 *pieds*.[25]

The commercial function of the quay was served by five openings in the wall leading to wharves (*cales*) which sloped gently down to the water and were almost totally submerged at high tide (Fig. 225). The wharves led directly into the town through openings which appear to have been unadorned, and simply closed by a wooden *barrière* or gate similar to those used on the outworks. There was one exception. Verrier used the location of the central wharf, leading as it did to the King's Storehouse and, via Rue Toulouze, to the citadel, as a pretext for another monumental design. The result was the Frederick Gate, a somewhat bizarre expression in wood of a classical gate complete with mansard roof and detached flanking obelisks (Fig. 85). The choice of material and the fact that it was set in a wall so much lower makes it appear more unusual than if it had been set in a regular rampart.[26] Shot to pieces in the first siege, it was not repaired.[27]

In spite of the shortcomings of the quay from a defensive point of view, little appears to have been done to improve it. Franquet's intention to raise the whole wall was never carried out, and presumably the 6-ft.-high palisade nailed to the parapet by the British to guard against escalade was left in place.[28] Efforts were concentrated on clearing the gravel that had accumulated at the foot of the wall and extending the wharves out into deeper water where ships of larger draught could be moored. This work had also been begun during the 1745-49 occupation and was continued by Franquet.[29] The utility of the quay notwithstanding, it appears to have been demolished along with the rest of the fortifications; although no explosive charges were used, it is represented in a ruined state on the 1760 demolition plan (Fig. 102). Seven years later, Ensign Sproule annotated his plan of the town: "This ruind front the quay almost wash'd away by the sea which if not prevented will in time overflow this street." Only two wharves are indicated (Fig. 103).

The sea was not prevented. The abandoned quay must have ceased to exist before the end of the 18th century. The various fishing shacks and wharves built along the shore throughout the 19th and early 20th centuries were all set directly on the gravel strand with no relation to the pre-existing structure.

A comparison of the aerial view (Fig. 110) with historical plans of the town (e.g. Figs. 84, 87) gives an indication of the extent to which the coastline has eroded. The gravel bar separating the Grand Etang from the harbour has moved so far inland that the Maurepas Bastion, once free-standing in the pond, is contiguous with the beach. The Pièce de la Grave and its *batardeau*, ditch and small segment of covered way have disappeared. Similar erosion has taken its toll at the opposite end of the quay, in front of the Dauphin Bastion.

Erosion was not uniform. In some areas gravel accumulation continued unchecked, the lower courses of the quay wall being covered and preserved even while the upper sections, aided by the British demolition crews, were disintegrating. Thus as the whole beach moved inland, the action scoured away the most exposed parts of the quay, but buried and preserved others.

The best-preserved portions were in the area of the right re-entrant angle, the wall having survived up to and including the base of the parapet (Fig. 226). The most fascinating aspect of the quay was the extent to which it had survived in pristine condition, providing evidence of construction techniques which had previously only been understood from the various documentary references. The method of sheathing the masonry in planks, as illustrated in Verrier's section (Fig. 225), could be examined in detail; the success of this innovation is immediately apparent in the good condition of the masonry and in the solidity of the lime mortar.[30] The sills of the gates and the road surfaces of the entranceways to the wharves were all sufficiently intact for reconstruction to be proposed with confidence (Fig. 254), while intact mooring rings -- in one case attached to a damaged ship's anchor set in the wall -- were useful in determining 18th-century sea levels. Little remained of the wharves themselves, but their outlines could be traced for a few metres out from the wall in the rows of massive pilings, the stubs of which still protruded above the sea bottom (Figs. 226, 227). Recovered pilings had been shod with wrought-iron tips or ferrules to facilitate their being driven into the sand and gravel. The *éperon* in front of the Dauphin Bastion, being of more solid construction -- in essence it was a salient of the quay wall itself, with a plank-clad masonry revetment and earth fill -- could be examined in plan, although its terreplein and parapet had long since vanished (Fig. 173).

Construction details apart, excavation of the quay added few new elements to what could be deduced historically. No structural modifications or major phases of occupation could be discerned and the upper sections comprising the flank embrasures and parapets were missing. The correlation between Verrier's plans and profiles and what was found in the field is one of the closest that has been established in Louisbourg.

Harbour Defences

One of the principal attractions of Louisbourg was its sheltered harbour; one of the principal preoccupations of the French was to command all parts of the harbour and entrance channel with artillery. Fear of a successful naval assault so dominated their thinking that the greatest fire-power was concentrated on the harbour rather than on the landward side: the Dauphin Bastion was given a 16-gun battery facing out across the water, while the later works at Rochefort Point -- the Pièce de la Grave and Maurepas Bastion in particular -- were designed specifically as coastal defences. Even the King's Bastion, situated as it was in an elevated central position, was so designed that its right flank could cover part of the harbour (Fig. 111). Thus, while the natural focus of study has been on the fortifications of the town, the extent of the efforts to defend the harbour should not be overlooked. In addition to the fire-power provided by the town walls, originally two, later three, independent batteries were constructed solely to control the harbour: the Royal Battery, the Island Battery, and finally the smaller Rochefort Point Battery.

The Royal Battery

Like all the major elements of Louisbourg's defences prior to the decision to fortify Rochefort Point, the design of a shore battery opposite the constricted harbour entrance originated with Verville, who was following recommendations made by his predecessor, l'Hermitte.[1]

Although the first detailed drawings of the Royal Battery bear Verrier's signature,[2] the work was carried out in accordance with the *devis* prepared by Verville.[3] Preparation of the site, supervised by Boucher, had actually begun prior to Verrier's arrival.[4] Essential construction took from the summer of 1724 to the autumn of 1728, when the gun carriages were installed,[5] although additional work, primarily the addition to the left flank to incorporate extra embrasures and two mortar platforms, continued for several more years.[6] It was not until early in 1732 that the battery was completely ready and manned.[7]

Although the Royal Battery may be thought of as a fortification with faces and flanks, it bore little resemblance to a bastioned work (Figs. 228, 229). The principal elements consisted of two elongated faces meeting at an obtuse angle to form a very shallow, inverted V facing the harbour. On each face 15 embrasures were constructed in the parapet to accommodate large-calibre cannon. At the ends of the faces were two short terminating walls that served as flanks, immediately behind which were two round towers, each consisting of two storeys supported by masonry vaults and surmounted by a platform with an embrasured parapet. To the rear of and parallel to the faces were the garrison barracks.[8] On the landward side, a ditch separated the towers and barracks from a small covered way and glacis. Flanking batteries were constructed on the counterscarp to cover the easterly and westerly shorelines. Thus, with the exception of the small embrasures on top of the towers, the artillery could only fire out into the harbour or at best along the shoreline: there was no strong defence to the rear. The landward defences were quite similar to those of the town side of the King's Bastion barracks -- a covered way with a *place d'armes* in front of the entrance and a glacis -- however, musketry loopholes were provided in the barracks wall overlooking the ditch, which was not the case at the King's Bastion. In addition, a loopholed masonry wall in the form of a rètrenchment occupied the gorge of the *place d'armes*.

Although not conforming to the bastioned system, the Royal Battery was not atypical of 18th-century coastal defences. The characteristic bastion shape so dominated land fortifications from the mid-16th century until the 19th century that it is easy to overlook the extent to which other forms were still employed under certain circumstances. The round tower, distinctively medieval or Renaissance in appearance, is one such example, appearing frequently in coastal defences of the late 17th and early 18th centuries. The Royal Battery would not be out of context on the Brittany coast amongst such sites as Tatihou and St. Vast-la-Hougue or, further south, Fouras near Rochefort. The architectural drawings of Claude Masse contain several proposals for coastal defences incorporating towers,[9] while Vauban himself designed a round tower complete with crenellation and machicolation for Belle-Ile.[10] Curving and straight batteries with no flanking defences were not uncommon in coastal situations, the prime consideration being to direct artillery fire at the marine approaches. Presumably it was felt that the by-then conventional bastioned trace could be dispensed with when it could be assumed that an enemy, even if he managed to land, could not conduct a regular siege with heavy artillery. Under these circumstances, round towers, commanding the surrounding country, would have good all-round observation and could resist lightly armed attackers.

The Royal Battery, with its powerful guns firing low over the water so as to strike enemy ships at the water line and with its twin towers capable of resisting small landing parties, conformed closely to the architectural forms of 18th-century coastal fortifications, but was by no means a perfect example of such works. The numerous criticisms its design provoked, its various construction modifications, and its inglorious performance in two sieges all indicate its serious shortcomings.

Never reluctant to question the wisdom or competence of the engineers at Louisbourg, St. Ovide referred scathingly to essential defects in the structure,[11] which not unexpectedly resulted in a ministerial letter of inquiry.[12] The main concern appears to have been with the field of fire. The faces of the battery were positioned so that the harbour entrance itself was not covered, nor were the anchorages in front of the town and at the end of the northeast arm of the harbour adequately covered. The governor's criticisms were scarcely rational: he faulted Verrier for adhering so clearly to Verville's original design, which resulted in the inadequate fields of fire, but cited Verrier's initiatives in constructing the additional flank embrasures as proof of the inadequacies of the design.[13] With great forbearance, Verrier explained that the battery was designed to complement the Island Battery; that the town anchorage was more than adequately covered by the Dauphin Bastion's Circular Battery; that aligning the right face of Royal Battery squarely to the town was an invitation to a successful enemy to turn all the guns on the town; and, finally, that orienting the left face to command completely the northeast arm would make the salient of the battery so acute that movement would be severely restricted.[14] Nevertheless, Verrier deemed it wise to extend the left flank so that the northeast arm was more fully covered.[15]

Damage caused by the severe climate necessitated maintenance and modifications. Initially, the masonry was covered with a thick coat of mortar (*crépissage*) in an attempt to make the joints less permeable. Where dressed sandstone had been used -- primarily on the gun embrasures -- the techniques of tying the stones together with wrought-iron crampons sealed in lead was applied for walls, parapets and embrasures were all deteriorating badly only three or four years after construction.[16] The practice of capping the summits of the merlons and parapets with turf, generally adopted in the mid-1730s, was also carried out at the Royal Battery. Where necessary, the tops of the walls that had become unstable were taken down to solid masonry.[17] The limited success of this technique is reflected in the continued deterioration of the walls and the extensive returfing of all major sections in 1744.[18] Upon his return in 1749, Boucher found the walls in poor condition through lack of upkeep, and prepared estimates for returfing yet again.[19]

The most effective solution to the chronic problem of crumbling masonry was, as employed on the quay and the Rochefort Point defences, the use of plank revetting on the outer surfaces of the walls, which Verrier proposed at the same time as he was occupied with returfing the summits of the walls.[20] The work was carried out that same year.[21]

Wood was also used to protect other features that stood up poorly to the heavy rainfall and the winter accumulation of snow and ice: the tower platforms, originally open to the elements. On one of the rare occasions when St. Ovide, Verrier and Le Normant agreed upon a course of action, their joint proposal to roof the towers met with ministerial approval,[22] and the work was done during the summer of 1735.[23] Boucher included wooden shingles to cover the towers in his repair estimates.[24]

By 1740 the effectiveness of the original design was again in question and Verrier had to respond to the doubts of Forant, the new governor. The contentious issue was the height of the faces, especially at the salient angle, where bedrock was highest. The soles of the embrasures there were only some 6 *pieds* above the beach and were an open invitation to an escalading party, the danger being aggravated by the crumbling masonry that offered footholds, already frequently exploited by the soldiers of the garrison who tried to sneak back unobserved after being absent without leave.[25] Verrier, aware of the effectiveness against shipping of batteries as close to sea level as practical, did not favour raising the height of the faces; instead, he proposed a small projecting work at the salient which would effectively flank both faces.[26] As first conceived, the work was referred to as a bastion and was to incorporate two levels of defence, the lower an enclosed gallery fitted with loopholes, the upper an open parapet.[27]

No action was taken immediately and when the project was finally carried out with other major repairs just before the first siege, it was in a much modified, simpler form. The work was now an *éperon* similar to that on the quay at the Dauphin Bastion; a single, open platform was at the same level as and accessible from the terreplein of the main battery, its walls were similarly revetted in planking and the parapet of each flank was pierced with two embrasures (Fig. 229).

Not all the work undertaken at that time was completed. Yet another governor, Duquesnel, decided that he should improve the battery's defensive capacities. His proposals included taking down and modifying the embrasures on the faces and flanks of the battery, reducing the number from 15 to ten on each face, and strengthening the left flank[28] (Fig. 229). While most modifications were carried out, the left flank was partially dismantled at the time of Duquesnel's death (9 October 1744) and remained so until the first siege. No evidence suggests that the proposed reinforcement was ever realized.

The bulk of the repairs and modifications had concentrated on the harbour side of the defences, and the covered way and its palisades were consequently suffering from neglect.[29] These deficiencies and the state of the left flank were considered so serious that the garrison commander recommended an immediate withdrawal once he saw that an attack from the landward side was imminent;[30] the battery was abandoned without resistance. At Verrier's insistence the work had not been demolished and it became an ideal base for the New Englanders, who trained what guns they could against the town and moved the others along the shore to new positions.

The Royal Battery was played an equally ignominious role at the time of the second siege. Already regarded with grave misgivings by the local authorities, it was probably only saved from demolition in the early 1750s by Franquet, who stressed its value in defending the harbour and as a deterrent to a direct naval assault.[31] It should, he felt, be maintained and sufficiently strengthened to be able to resist an assault by land and only abandoned, if absolutely necessary, after its artillery had been removed.[32] Yet once again no attempt at resistance was made when the British approached. Fearful of seeing the place still intact but in their enemies' hands, the French decided to disable it beyond the possibility of immediate repair.[33]

Used as a guardpost following the capture of the town, the Royal Battery was finally given the *coup de grâce* by British engineers in early November, 1760.[34] Used as a quarry for building materials as the modern town of Louisbourg began to grow up around the harbour, the battery was soon reduced to a low grassy ridge, its outlined still clearly demarcated by the ditch and glacis, and by the mounds at the tower locations.

Although situated away from the open sea, the battery has nevertheless been subjected to severe erosion. Gale-force winds from the southwest drive large waves the full length of the harbour, scouring the shore as they pass, while more easterly winds blow along the channel into the harbour to strike the battery directly.

A preliminary investigation of the site was made in 1959, when Harper attempted to determine the extent of erosion. He concluded that most of the escarps of the faces and substantial portions of adjacent rampart fill had already been washed away, and recommended that, to prevent further loss, the escarps be rebuilt as sea walls behind which the rest of the battery could be preserved.[35] In itself the recommendation presented a practical solution to the accelerating encroachment of the sea (Fig. 230).

Perceived and carried out as primarily an engineering project, a solidly founded barrier of reinforced concrete was installed with no thought of stabilizing and retaining any of the existing masonry, and only scant regard for the archaeological investigation and recording of features that were removed as construction proceeded.[36] The work was undertaken as an initial phase in the total reconstruction of the battery, but had to be abandoned since the legal boundaries of the park had not been established and the status of the Royal Battery site remained uncertain.[37] As a result, further efforts concentrated on the citadel of the town itself. The Royal Battery is now included within the park boundaries and further erosion by wave action has been halted, but no stabilization has been carried out.

The Island Battery

From the outset it was never intended that the Royal Battery should alone defend the harbour. When St. Ovide criticized its shortcomings, he was studiously overlooking the issue of interrelated fields of fire, fundamental to the defensive concept adopted for Louisbourg, for he himself had stressed the necessity of complementary batteries even before the defences of the town had been properly thought out.[38] Noting how essential cross-fire would be to resist attack by sea, he had proposed four batteries, instead of the three that were built (the Royal Battery, Island Battery, and Dauphin Circular Battery), the fourth to be located not far from the site chosen for Royal Battery. To guard against an attack following a successful landing, the two north-shore batteries should be provided with adequate defences to the rear, although the Island Battery, because of its inaccessibility, and the Circular Battery, because of its proximity to the town defences, did not require such precautions.[39]

The minister, in agreement with the governor, had also insisted on the necessity of commencing work on the harbour batteries as early as possible,[40] although nothing was done at the island until materials were stockpiled towards the end of 1726 for an early start the following construction season.[41] St. Ovide had clearly won his point and the design of the Island Battery was compatible with his own ideas. Moreover, he recorded with a hint of malicious satisfaction: "M. Verrier is not wholeheartedly in favour of M. de Verville's plan and it appears to us that he has made the best out of what he had to work with"[42] (author's translation). Strategically placed though it was at the mouth of the harbour, the island was so small and narrow that it permitted little flexibility in design. Perhaps for these reasons there was little criticism of the battery, at least by the French; certainly there were no lengthy disputes such as engendered by the Royal Battery. The basic plan Verrier proposed in 1726 was retained with minor modifications for its entire history[43] (Fig. 231).

The main difference between the earlier and later plans was less in the disposition of the battery and its embrasures than in the size and location of the barracks. Initially, the building was envisaged as closing off almost the entire length of the gorge of the battery, but what appears to have been constructed was a much shorter unit located closer to the long face of the battery (Fig. 232). A short section of low wall (*mur d'épaulement*) was added at the rear of the battery to cover the only possible landing place on the south side of the island.

The principal elements of the Island Battery consisted of a flank, facing northwest into the harbour, and an elongated face terminating in a curve (Fig. 232). The straight section of the face brought maximum fire-power to bear on the narrow channel through which all shipping had to pass, while the curving section provided a wide arc of fire in the direction of the shallows and other rocky islets off the harbour mouth. The short dogleg wall between the flank and the face had a single embrasure, allowing some measure of cross-fire. The safest landing place is a small, rocky beach on the northwest end of the island; hence the entrance to the battery was in this area, a passageway through the flank near its intersection with the face. Within the walls were the barracks, a small powder magazine, and a cistern to ensure a ready supply of fresh water.

Inaccessibility was the surest guarantee of the battery's security. The tiny island is surrounded by rock-strewn shallows washed by treacherous cross-currents and there are virtually no safe landing places in any but the calmest weather. Indeed, Verrier was only too anxious to complete the work as quickly as possible, considering his frequent inspection trips to be extremely hazardous. On one occasion the boat overturned and only the fact that the waves cast them up on the beach at Rochefort Point saved Verrier, Boucher and the contractor from drowning.[44]

As possibility of an enemy landing was nevertheless a matter of concern, the partial enclosing of the rear with an *épaulement* was regarded as "de la dernière importance."[45] The new wall was designed to be plank revetted -- an indication that already problems with the earlier masonry were beginning to be manifest. The construction problems common to all the fortifications are seen in the proposals to take down the merlons of the embrasures by 2 *pieds* and to recap them with turf (Fig. 233); the methods proposed and the general need for such work were discussed by various officials.[46] Whether the outer surfaces of the walls were encased in planks as part of the repair work is not know, but in 1749 Boucher commented that the masonry had generally withstood the siege quite well and had remained intact behind the plank revetment although the parapets had been totally demolished.[47]

The improvement Franquet recommended consisted primarily of closing the rear of the battery with a loophole wall *(mur crenelé)* and adding short flanking walls all around so that the entire perimeter could be swept with grape- or small-shot in the event of a surprise landing. The only sector that could not be adequately covered was the curved portion and a makeshift *fausse-braie* would have to be thrown up if attack were expected there.[48] Because, as the engineer recognized, the island could rely to a great extent on its natural defences, any enemy attempt to land being possible only with a calm sea and heavy fog or cover of night, his proposed modifications were never realized.

The crucial role of the Island Battery in the defence of the harbour -- and, by extension, the town -- was fully appreciated by the attacking forces in both sieges. On both occasions, even though a landing had been successful to the southwest of the town and an artillery-supported siege opened against the landward defences, the British fleet hoped to force the harbour entrance and speedily conclude the campaign. In the first siege the New England troops launched an ill-fated assault on the Island Battery, for with its guns still intact, no ships could run the gauntlet of the narrow channel.[49] The besiegers then resorted to the more logical tactic of bombarding the battery into submission from Lighthouse Point. The location of the battery vis-à-vis Lighthouse Point was its gravest disadvantage and one that the victors were quick to criticize.[50]

No attempt at a direct assault was attempted during the second siege. Wolfe systematically worked his way around the harbour, setting up redoubts and batteries as he went, until he was in a position to silence the battery at leisure. Inasmuch as the battery was an effective deterrent to a naval attack and obliged the enemy to take time-consuming measures on the far side of the harbour, it must be regarded as having successfully fulfilled its function.

The Rochefort Point Battery

At an early stage in the preparing of a fortification concept for Louisbourg, a battery had been envisaged at the tip of Rochefort Point (Fig. 69), but the project was abandoned when the three principal harbour batteries were established. Later a fourth was added when Verrier located the Pièce de la Grave between the quay and the new fortifications at Rochefort Point which also contributed to the harbour defences.

This was apparently not enough. Agitation for yet another battery to defend the harbour approaches came from the navy. The commodore of a French fleet at anchor in the harbour, de Salvert, concerned about the safety of his ships as war with Britain appeared inevitable, persuaded the governor to allow him to construct at the extremity of Rochefort Point a 12-gun battery which would be able to fire on a blockading fleet and any bomb-ships sheltering behind the island off the harbour mouth. First established in 1755, the battery was two years later extended to cover the southerly approaches as well.[51] The work appears to have taken the form of a simple platform following the coastline (Figs. 98, 101). As a complement to the Island Battery and as a replacement for it when the British guns at the lighthouse silenced it, the Rochefort Point battery proved to be a valuable addition to the harbour defences.[52]

The Sieges

A detailed account of the 1745 and 1758 sieges is beyond the scope of this report (reference may be made to several published sources[1]), but an analysis of tactics and an attempt to identify siegeworks positions are necessary prerequisites to an assessment of the degree to which the fortifications met expectations.

The 1745 Siege

The two sieges were remarkably similar. The first siege has been characterized, more in admiration than in criticism, as "a campaign of amateurs."[2] Certainly there were many irregular and even bizarre aspects to the campaign, which appears to have depended as much upon luck, audacity and Divine Providence as upon proper planning. In overall terms, however, there is no doubt that the organizers' strategy was sound. A direct assault on the harbour by naval vessels being rightly considered impractical, the expedition set ashore at the nearest safe landing place in Gabarus Bay, then moved overland to positions around the harbour and in front of the fortifications. Taking the harbour batteries was essential prior to any attempt to force the entrance to the harbour, and at the same time, siege batteries would attempt to destroy the landward fortifications.

Thus a two-pronged attack developed, the first major move being against the Royal Battery. No assault of this strategic work was necessary as the French precipitately abandoned it and the New Englanders walked in without firing a shot. The structure had not been disabled by the departing garrison and its guns had been inadequately spiked; consequently, the besiegers used the battery as a base and opened fire almost immediately with the four 36-*livre* cannon whose embrasures allowed them to be trained on the town.

At the same time, the beginning of the land approach to the town was signalled by the opening of the Green Hill Battery. The location of this battery has caused some confusion to historians, but the confusion is more apparent than real and stems from attempts to locate it by correlating various documentary sources rather than examining the ground. Pinpointing Green Hill on the several plans of the siege (Figs. 234, 235, 236) cannot be done accurately because the plans themselves are not sufficiently accurate. Various prominent landmarks such as ponds, White Point and Flat Point are all sufficiently displaced, when compared to modern topographic sheets, that Green Hill may be any of several hills in the area. But it was selected, even before the expedition set sail, as the one hill that commanded both the town and all other heights in the immediate vicinity,[3] and only one hill meets this requirement (Fig. 255).

Green Hill was nonetheless too far away for effective artillery bombardment; shots fell randomly with little apparent effect on the defences. Batteries closer to the town had to be established. Again, the lie of the land dictated the obvious route: moving down the slopes of Green Hill in a northeasterly direction, one comes to a series of lower hills between the Barachois and the King's-Dauphin front. The area, known as the *fauxbourg* of the Dauphin Gate,[4] was divided into properties, one of which, belonging to Jacques Rabasse, was chosen as the location for a battery of Coehorn mortars. Although no surviving maps or plans indicate exactly where this property was, the description of a *hauteur* on the edge of the Barachois near the *rue du fauxbourg* makes the high ground overlooking the pond a logical choice, as the plans showing the siegeworks suggest, imprecise though they are, and the hill may be identified with some confidence (Fig. 255). Located on a ridge parallel to and some 460 m from the right face of the King's Bastion, the Rabasse Battery's field of fire was depicted as concentrating on that area of defences, although lines of fire were also drawn between the battery and the right flank of the Queen's Bastion. It is not clear whether the fire is incoming, outgoing, or both (Fig. 235).

The weak point of the *enceinte* was the Dauphin Bastion, and it was there that the major efforts of the land attack were concentrated. Taking advantage of the cover offered by the ridge extending from the Rabasse height toward the Dauphin Bastion, the New Englanders dug a trench in which two additional batteries could be erected. One, some 400 m from the Dauphin Gate, was used primarily to neutralize the guns of the right flank of the King's Bastion, which effectively flanked the Dauphin Bastion and vicinity, delaying the advance. The other, on the "hauteur de Francoeur," was almost at the foot of the glacis, the distance to the gate being estimated at a mere 250 yards (222 m). Other descriptions make it clear that this hill was the one which had been a cause of concern to St. Ovide in the 1730s and which Franquet lowered by 7 *pieds* in the 1750s; at this time, because of a lime kiln built there for the repair work to the Dauphin Bastion, it was referred to as the "hauteur du four à chaux."

From such an advanced position, the tenaille front incorporating the gate was at point-blank range. The battery was within musket-shot of the ramparts, and much small-arms fire was exchanged. All efforts now concentrated on opening a breach in the wall. The task was not without danger: the battery was exposed to the fire from the bastion it was attacking and from the right flank of the King's Bastion. The area in front of the Dauphin was also exposed to fire coming over the water from the Pièce de la Grave (Fig. 235), to the great discomfort of the gunners in the advance batteries.[5]

The Royal Battery had been aligned so that only a few of its guns could be used directly against the town, but the New Englanders promptly removed the remainder from their embrasures and set them up in field batteries. Some were used to supplement the Coehorn mortars of the Rabasse Battery and others were destined for a battery being constructed on a bluff overlooking the harbour and directly opposite the Dauphin Bastion. Known to the French as the "hauteur de Martissan" after the owner of the property (Fig. 255), to the English it was Titcomb's Battery, named after its commander, Major Moses Titcomb.[6] Although farther from the bastion than the Rabasse Battery (670 m as opposed to 460 m), the guns in the new position could fire over the water at the exposed and unprotected masonry of the Dauphin Gate and Circular Battery. No intervening ground or glacis would deflect the shot. The effect of 36-*livre* (the equivalent of British 42-pounder) cannonballs under such conditions was devastating.

The siege was progressing well as far as the attackers were concerned and it seemed that events would soon culminate in a successful assault, but there was one drawback. Ideally, an assault should combine the army, storming a breach, and the navy, forcing the harbour, but while the land advance had established a breach and was ready to launch an assault by the end of May, the harbour batteries had yet to be silenced. Commodore Warren of the British squadron would not risk his ships until the Island Battery no longer constituted a threat.

Rather than carry out the logical, if more painstaking, steps of encircling the harbour and bombarding the Island Battery from a height, the New Englanders attempted a direct assault on the island, but were repulsed with the heaviest losses they were to endure throughout the whole campaign. Only then were guns taken around the harbour to Lighthouse Point and the Island Battery reduced. The way into the harbour was now clear and an assault imminent; the town surrendered.

The 1758 Siege

A landing in force on the same beaches as before was the prelude to the siege of 1758, although this time the French had endeavoured to forestall such an eventuality. Entrenched positions for troops armed with muskets and even small cannon were established around the shores of the most suitable landing places to both the north and the south of the town (Fig. 237), but in the face of resistance, the British troops landed and began to encircle the harbour. As before, silencing the Royal and Island batteries was considered a priority, and as before, the French had abandoned Royal Battery without a struggle, but lest it be used against the town, they had removed its guns and partially demolished its defences. Thereafter, the Royal Battery had no importance in the sequence of events.

The experience of the first siege -- and perhaps common sense -- indicated that the best way to deal with the Island Battery was from the commanding heights of Lighthouse Point and the campaign again took the form of a two-pronged attack. Wolfe struck north along the harbour shore, then pushed east and south to the lighthouse, while the other forces took position on Green Hill and began establishing a wide arc of batteries.

Once the Island Battery had been put out of action, Wolfe returned to take up an advanced position on the north of the land attack, with the intention of pushing forward to "two Eminences not far from the West Gate."[8] The most detailed and demonstrably accurate plans of the siege establish that these hills were the "hauteur de la justice" and the "hauteur du four à chaux"; the latter position was never operational as the town surrendered before the battery was fully established (Figs. 240, 242).

Apart from the much larger, professional British force in 1758, the major new dimension as compared to the earlier siege was the presence of a French naval squadron in the harbour. McLennan lists ten ships with armament ranging from 16 to 74 guns,[7] a force to be reckoned with in terms not only of sheer fire-power but also of the number of men capable of augmenting the defence of the town. Much effort therefore went into building siege batteries directed at the ships rather than the town, and earthworks intended to screen troop movements and encampments from the fire of the potentially lethal floating batteries. This in part explains the numerous siegeworks ringing the northeastern sector of the harbour beyond the Royal Battery (Fig. 238). In fact, only one French ship, the 36-gun frigate *Aréthuse*, was ever used to any effect, and the French failure to exploit to the full the aggressive potential of the other ships has been severely criticized. The culmination of the siege was the destruction by fire of all but two ships. (One of the two was captured by a hotly contested cutting-out expedition and the other, the *Aréthuse*, escaped.[9]) The demoralized French surrendered.

Although this siege was carried out by a professional force, it gives little impression of the ordered symmetry of a classic siege such as might be expected in a European context. No extended parallels are apparent and only in the direction of the Dauphin Bastion was there a systematic advance. The attack developed to the south of Green Hill consisted of a line of batteries extending away from, rather than parallel to or approaching the *enceinte*, the positions being dictated not by principles of geometry but by the lie of the land. A low, broken line of hills and knolls stretches across the peninsula on a roughly north-south alignment, and the trace of the defences is such that, except for the proximity of the Princess Bastion to the isolated point of Black Rock, the Dauphin Bastion is nearest to any high ground. The expanse of open bog is greatest in the southwesterly quarter; the high ground is the only choice for siege artillery. The impracticality of an assault over this terrain does not justify McLennan's criticism that extending the attack southward from Green Hill was futile.[10] The issue of the ships in the harbour had not been resolved at the time the southerly advance was made, and it made good sense to keep the siege trains out of reach of the harm that the *Aréthuse* had demonstrated could be inflicted. Moreover, the weakness of the Princess Bastion was appreciated by those familiar with the town from the 1745-49 occupation, and the opportunity existed for extending an attack along the coastline to the vantage point of Black Rock. Franquet had been fully aware of this danger, recommending a detached redoubt in the area or at least razing the rock. Failing to accomplish either, he made do with an entrenched line from the glacis to Black Rock and small cannon mounted in field positions on the only high points along the coast (Fig. 240). Any advance following the coastal plain would be contested directly and would also be subject to flanking fire from the ramparts. Under such circumstances, long-range batteries to destroy the flank embrasures are almost mandatory as a prelude to an advance; there is no need to assume that they would be attempting to breach the walls. Even if no advance were contemplated, sound siege tactics consisted of harassing the defenders over as wide an area as possible. Constantly on the alert, uncertain as to where the main attack would develop, unable to concentrate their strength in one sector, obliged to use more ammunition than they could afford, they would be forced all the more quickly to surrender.[11]

Whether or not, as part of the long-range bombardment, conscious attempts were made to damage the town and to terrorize the inhabitants is open to dispute. Certainly the French believed the worst of their enemies[12] and McLennan cites Amherst's orders to aim at the fortifications and not the town as if his gunners had to be instructed to desist from conduct unbecoming the rules of siege warfare.[13] Taking into account the compact layout of the town behind the walls and the inaccuracy of 18th-century artillery, it seems inevitable that a high proportion of projectiles would land within the town whatever the gunners' intentions might have been. In the siege of Quebec the following year, there was no doubt: Wolfe, desperate to force a surrender, resorted to the deliberate bombardment of civilian targets.[14]

As topographical detail is more accurately depicted on some of the plans of the second siege than on those of the first, identification of positions may be made more confidently. Central to both sieges is Green Hill. Wolfe appears to have bypassed the Rabasse position and set up a battery on the "hauteur de la justice," which had not been exploited in the first siege. His next move, toward the lime-kiln hill, was common to both sieges. Similarly, across the Barachois, the "hauteur de Martissan" (Titcomb's Battery of the first siege) was again a logical choice; however, the batteries were now located farther from the shore, probably on the ridge above the present-day road, and considerably more guns were deployed. While the exact location of the batteries on the far side of the harbour may be debated, the terrain leaves little room for many alternatives.

Fieldworks

Positive identification of actual remains in the field is far more problematical. The terrain itself is a large factor. In a region were topsoil is at best a thin, stony litter over bedrock or waterlogged peat bog, the survival rate of temporary earthworks can scarcely be expected to be very high. Dense forest cover since the end of the French occupation has obscured many of the positions and made field investigation an arduous, frustrating task in which aerial surveys have been of only limited help. Nor has subsequent settlement contributed to preservation of the works around the harbour or closest to the town. On the Rabasse, Francoeur and Martissan heights no discernible traces of batteries or trenches survive, all three areas having been cleared for farming from the 18th century until the early 1960s, and the majority of works clustered around the northeast arm of the harbour have been effaced by the growth of the present-day town.

During the first siege only five batteries (not counting the Royal Battery) were established, and all the areas except Green Hill are devoid of any vestiges from either siege. The identification of Green Hill topographically is further confirmed by the numerous trenches, depressions and remains of breastworks on the crest and slopes, scarcely recognizable though most of them are. It was used as a starting point for the extensive works employed in the second siege and therefore the basic assumption is that any earthworks located there are attributable exclusively to the second siege. Certainly there was no way of distinguishing works of the earlier period.

Some of the best-preserved and most readily identifiable fieldworks are those constructed by the French. Franquet's Black Rock entrenchment has already been mentioned. Of the several V-shaped positions forward of this area, three are still clearly visible on knolls at the edge of the shore. The extensive lines of trenches in the Flat Point landing area and across the White Point peninsula have all survived virtually intact. At the main landing place of Kennington Cove (L'Anse à Cormorandière), trenches along the east end of the bay may still be seen, but coastal erosion and land clearance have destroyed everything else. North of the lighthouse, substantial traces of trenches are still visible at Gun Landing Cove (L'Anse à Gauthier) although coastal erosion is accelerating there.

The 1758 siege was characterized not only by the number of batteries and trenches established, but also by the many redoubts and defenced encampments flung up by the British. In part necessitated by the threat of the French ships' guns, they were required as a standard precaution against sorties by the besieged and any relief forces that might come to the aid of the town.

A British plan of the campaign shows the troop dispositions in detail (Fig. 238). The main encampment is well to the west of the town, strung out along the ridges overlooking the Flat Point (Landing Cove) Brook. Turning thence in a northeasterly direction, various camps and redoubts occupy the high ground overlooking the harbour itself but out of effective cannon range. In the hills above the Royal Battery are still more encampments, together with batteries firing on the ships. A final encampment, established by Wolfe's brigade, is situated on the ridge above L'Anse à Gauthier, northeast of the lighthouse. On the lower ridges immediately behind Green Hill and dominating the Barachois and southwest arm of the harbour are advance posts and siege batteries. Across the open ground leading to Green Hill is an *épaulement* to protect troops from the fire of the *Aréthuse*.

Rectangular earthworks and depressions are still to be found on the wooded slopes along Flat Point Brook. To the south of the modern road to Kennington Cove, the remains follow the ridge to the west of the brook. North of the road, similar remains may be traced until their alignment intersects the brook, but beyond that, no positive identifications have been made.

In the area of Green Hill, the *épaulement* has vanished but the square redoubt on the knoll immediately to the northwest is still visible. Closer to the Barachois, trenches and redoubts clustered around the stream may still be seen, although the area has been disturbed by the construction of Marconi's towers in 1901, other buildings in the early 1900s, and a recent picnic ground.

Above the Royal Battery, the most prominent feature still to be seen is a large, rectangular enclosure comprising a ditch and raised earthwork -- the remains of a large troop camp. Vague trench outlines may still be detected on the slopes behind the camp, but any traces of the emplacements on the forward slopes have been obliterated by the construction of the modern visitor reception centre.

On the far side of the harbour are the well-preserved remains of a double-crown redoubt of earth, occupying twin knolls overlooking what is today known as Havenside. From the way the work is positioned, it was designed not to fire on the ships, but to thwart any surprise attacks against the various batteries set up in the Lighthouse Point area.

For the most part, what has survived of the various siegeworks is badly degraded and barely recognizable. The best-preserved features are the square encampment above the Royal Battery, the double-crown redoubt at the northeast end of the harbour, and the French entrenchments around Flat Point Cove.

Conclusions

Twice besieged, Louisbourg was twice taken. From its inception, the place was criticized by a succession of governors for the inadequacy of its defences and faults in its construction which were attributed to the shortcomings of the engineers and contractors. The litany of complaints about the climate and the poor quality of the masonry which is such an integral part of the official correspondence certainly support the view that the place was in constant, abysmal disrepair, a helpless prey to any enemy who chose to attack it. Two statements, one from a French source, the other from a British, illustrate the prevailing attitude:

> The walls have to be recoated with roughcast mortar every three years, the harshness of the climate causing the roughcasting to fall away, which causes the joints [in the masonry] to deteriorate, the stones, being extremely irregular, cannot be laid in regular courses with proper joints as is done everywhere else ... the climate of Ile Royale is so hard, ... the weather there changes easily several times a day, for it can happen that it is snowing heavily, the next moment it is raining down by the bucketful and within the same hour it freezes so hard as to shatter stones; these freezing temperatures following the heavy rain are what distort the walls and make them work apart so that they can no longer stand....[1] (Author's translation.)

More disparaging was the opinion of the British during the 1745-49 occupation:

> Upon the whole the General design of the Fortifications is Exceeding Bad and the Workmanship worse executed and so Disadvantageously Situated that almost every rising Ground or little Eminence Commands one part of other, that either a Vast Sum of mony must be laid out to Fortify it properly or it will never answer the Charge or Trouble.[2]

The vulnerability of the low-lying site was of concern to the French also. The problems with masonry, particularly the parapets and embrasures, which caused Verrier so much trouble in every sector, need no further elaboration. Franquet's detailed reports on the dilapidated condition of the escarps and the major repairs needed to restore them to their proper state clearly demonstrate that the problems were, if anything, worse in the years immediately preceding the second siege.[3] The outspoken criticisms heaped upon Franquet by the military commanders, who held him chiefly responsible for the inadequacies of the defences,[4] together with statements made during the siege to the effect that the masonry could not withstand the concussion of the guns on the ramparts as they were fired,[5] reinforce the overall impression of decrepitude and vulnerability.

Was Louisbourg an expensive failure as a fortress? The very use of the term "fortress" conjures up an image of grand military strategy not entirely appropriate to the context of Louisbourg and should be applied with reservation. While it would be fatuous to contend that a town surrounded by ramparts and with a population comprised in large part of troops was not a fortress, the town was not conceived of as performing the same role as the strategic frontier places such as Neuf Brisach or Briançon; it was not placed on Isle Royale as part of a grand territorial design. Louisbourg's origins were commercial rather than military.[6] French usage sheds some light on the issue. While the word "forteresse" exists in the language, it it rarely applied to fortified towns, "place forte" or "ville fortifiée" being the more usual terms; "forteresse" is used poetically rather than technically, or sometimes to refer to prisons.[7] The term "forteresse" was never applied to Louisbourg, and the alternatives appear to have been used rarely, if at all. On the many maps and plans and in the official correspondence such phrases as "la ville de Louisbourg," "la ville de Louisbourg et ses fortifications," occasionally "le port de Louisbourg," and often simply just "Louisbourg" are common currency. This is natural both in the European context in which towns, almost by definition, were walled, and in the context of a town whose *raison d'être* was fishing and commerce, not frontier defence. The same argument may be applied to numerous examples: we speak of

Quebec City and the City of Montreal, but never think of them as fortresses, and in spite of its extensive defences, Portsmouth is a harbour town, not a fortress.

Why does Louisbourg emerge from history as a fortress rather than a town? Despite the interest and patriotic fervour briefly aroused by the two successful sieges, Louisbourg was never the focal point of British colonial policy in North America and has consequently become little more than an historical footnote, a stepping stone in the path of conquest. Historians treating of the grand themes -- the epic of empire, the struggle for dominance of a continent, the birth of a nation -- consider Louisbourg primarily in the context of Anglo-French rivalry. The place flits briefly across the stage as a nest of privateers and a stronghold threatening the expansion of New England and hence as the proving ground for the arms of a nation not yet born; later it is the obstacle barring the route to Quebec and Canada.[8]

While a case may be made for these points of view, to regard Louisbourg exclusively in such an historical context is to overemphasize its military and strategic aspect. The very term "fortress" has powerful military connotations which distort our perceptions. To anyone unfamiliar with the detailed studies of the town and its commerce undertaken over the last two decades, the realization that there was more than a military presence comes as a surprise. The site was not chosen as a strategic frontier location controlling access to a hinterland in the manner in which, for example, Mont Louis was established in the Pyrenees.[9] The population was not conscripted to maintain the fortifications; the fortifications were constructed to defend the town and harbour. Thus, in relation to the European background, Louisbourg was a fortified town, and isolated place vulnerable to attack and therefore, in accordance with French custom, furnished with a defensive perimeter. By any European standards, this perimeter was modest.

As first conceived, the *enceinte* of Louisbourg was little more than a basic horn-work like that used to cover a *faubourg* of a large town such as Besançon or Verdun (Fig. 42). Smaller towns of roughly the same size as Louisbourg -- or even less -- were, because of their strategic locations, much more strongly defended. Montmédy in the Ardennes, Le Quesnoy on the northeast frontier of France, and Neuf Brisach in Alsace may be cited among numerous other examples (Figs. 12, 47, 55). It is only when we consider even smaller places, located some distance to the rear of the principal frontier barriers, that anything comparable to Louisbourg may be found. In terms of the actual trace of fortifications, it most closely resembles Mont Dauphin, located on a narrow, rocky outcrop commanding the valleys leading to the Italian passes guarded by the mountain stronghold of Briançon, and the port of Antibes on the Côte d'Azur (Fig. 243). The latter in particular invites direct comparison with Louisbourg because of its sheltered port and the defences which cut off a promontory of land enclosing the port. The headland on the other side of the port entrance commands the approaches with a square, four-bastioned fort (Le Fort Carré) of early 16th-century origin.[10] Yet even in the most simple fortifications, more extensive use of outworks is evident in the European examples than was ever the case at Louisbourg.

In a strictly North American context, Louisbourg's pre-eminence is perhaps more readily understandable, Parkman claiming it to be "reputed the strongest fortress," French or British, in North America, with the possible exception of Quebec.[11] If we are to take "fortress" to apply in a general sense to any fortified work, this was undoubtedly true, but in the sense of fortified towns, we may legitimately ask what others existed at that time. The French holdings in North America were vast, extending up the St. Lawrence to the Great Lakes, westward to the foothills of the Rockies, and south along the Ohio and Mississippi river systems through Louisiana to the Gulf of Mexico. But the area could scarcely be considered overpopulated, 90 percent of the inhabitants clustering in a small region along the St. Lawrence on each side of Quebec City; any claim to the rest was "an illusion of territorial power."[12] Towns were few and far between and, in essence, numbered only five: Louisbourg on the Atlantic coast, Quebec, Trois-Rivières and Montreal on the St. Lawrence, and New Orleans on the Gulf of Mexico. Of these, only three -- Louisbourg, Quebec and Montreal -- were furnished with bastioned masonry fortifications (Figs. 244, 245). The defences proposed for New Orleans in 1722 were never realized.[13]

Elsewhere, strategic routes were guarded by isolated posts whose function was essentially military. Controlling access to the Acadian peninsula, for instance, were Forts

Beauséjour (Fig. 246) and Gaspareau; south of Montreal along the valley of the Richelieu, leading to Lake Champlain, were Forts Chambly, St. Thérèse, St. Jean and Isle aux Noix; on Lake Champlain were Forts St. Frédéric and Carillon (Ticonderoga); further west on the upper St. Lawrence and Lake Ontario were Forts La Présentation, Frontenac and Niagara; Fort Presqu'Ile guarded the portages from Lake Erie to the Ohio River at the headwaters of which was situated Fort Duquesne (Pittsburg). Between Lakes Erie and Huron, Detroit was at once a frontier fort and an important trading post, as was Michilimackinac on Lake Michigan, while a string of lesser posts extended across the prairies as far as the Saskatchewan River. Fort Chartres guarded the southerly route toward the Mississippi. Although New Orleans was never fortified, several forts were constructed around the bay from time to time. Only a few forts -- Niagara, Chartres, Chambly, St. Frédéric and Carillon -- made extensive use of masonry; the rest were enclosed by simple wooden palisades or earthen ramparts, or a combination of both, and for the most part, the traces consisted of four bastions based on a square figure. Beauséjour, with five bastions, was an ambitious exception. Used as strategic bases in the French and Indian War (1754-63), the forts played the role reserved for fortresses in the European theatres of war, although no regular artillery sieges were conducted against them. Only against the essentially European fortifications of Louisbourg and Quebec were European methods employed (in both cases made possible by sufficient command of the sea to permit the transportation of siege artillery). Viewed in this context, Louisbourg may be seen not as one of the great fortresses, but as one of the very few places only remotely deserving of the description.

Mighty fortress or no, Louisbourg certainly absorbed a disproportionate amount of funds compared to what was spent on fortifications elsewhere in New France, and Thorpe has demonstrated that expenses actually exceeded those on Quebec.[14] Given the construction problems that plagued the place and loom so large in the official correspondence, were the fortifications an unjustifiable extravagance, an attempt by European engineers and contractors to impose European concepts on a North American context to which they were ill-suited?

There did not seem to be anything over-ambitious in the simple line of redoubts and retrenchments Verville initially proposed for the three possible locations he had in mind. Nor was the concept of *redoutes bastionnées* without precedent. A more ambitious series of redoubts had already been envisaged for Quebec by Beaucours and Chaussegros de Léry (Fig. 247) before the decision was made to defend the town with a continuous *enceinte;*[15] the substantially intact foundations and parts of the escarp of the bastion or *éperon* in front of the *redoute Dauphine* demonstrate that, in its intended form, it would have looked quite similar to the originally free-standing King's Bastion at Louisbourg. In the case of Quebec, a line of independent redoubts was abandoned in favour of a regular, bastioned *enceinte* constructed in advance of the original alignment, whereas at Louisbourg the communications between the redoubts were strengthened and revetted in masonry. How this decision came about and who took it is not clear. Thorpe would have it that in spite of instructions to keep the defences simple in accordance with the size of the colony, Verville exceeded his mandate and committed the government to an extensive, ambitious construction programme.[16] Little justifies this assertion since the engineer's first proposals were in line with his instructions and only later was he authorized to use masonry for anything other than the King's Bastion.[17]

It has further been asserted that the decision to use masonry was a grave error, the more rudimentary colonial techniques, using earth and timber, as proposed by engineers with colonial experience, such as l'Hermitte, being far more suited to the conditions.[18] While a commitment to masonry was indisputably costly in terms of time, effort and money, once the original choice of site and the decision to fortify it had been made there was little alternative. A masonry escarp was a means to an end, not an aesthetic whim; its function was to retain the earthen mass of the rampart and to present to an enemy a steep, unscaleable surface. The undesirable characteristics of masonry in the face of artillery bombardment were fully appreciated by the French engineers, but earthworks alone would erode too quickly, filling the ditches and forming gentle slopes that would present less of an obstacle; this was a criticism levelled at the earlier Dutch style of fortifications built in much less severe climates.

At Louisbourg, conditions were poor. The builders experienced difficulties in excavating the ditches in all sectors of the fortifications, encountering bog, boulders, high water tables and bedrock. The ditches did not produce enough earth; when the new *enceinte* at Rochefort Point was constructed, topsoil had to be stripped from within the town, even from the cemetery, to add to the rampart fill. Even so, Franquet's general criticism of the fortifications was that they were too low and their parapets not thick enough. The earth that could be found was of poor quality: stony, glacial till that is heavy and sticky when wet but lacks consistency when dry. The French complained of its poor quality during construction, as did the British when they tried to tunnel into the ramparts to place their demolition charges, and the recent archaeological excavations have borne out these complaints all too well, extensive shoring being the only remedy to frequent trench collapse. Wherever a soft cover of earth was desirable to absorb enemy fire, as on the glacis, a distinctive feature of the fill was the quantity of stones at the bottom, the better earth, in such scarce supply, being carefully reserved for the upper layers (Fig. 219).

Lacking consistency, the earth finds its natural angle of repose on a fairly gently slope: approximately 35 degrees to the horizontal as opposed to the 45 degrees theoretically attainable. While a steep slope could be achieved with careful terracing, a distinct difference existed between what was originally proposed and what was revealed in archaeological sections across the slope of the curtain ramparts. Both Verrier's original specifications and Franquet's recommended revisions called for a 45-degree slope, but neither of them achieved this, the slopes being much gentler. Thus, even if there had been sufficient supplies of earth to raise the ramparts entirely in that material, the steepest slopes attainable would still have been far too easily assailed. Some form of retaining wall was therefore necessary. The French were largely unsuccessful, in their quest for durable palisade posts, and the posts installed rotted very quickly; wood could never have been a reliable means of retaining the ramparts. Masonry was the only solution available.

The error lay less in choice of technique than in choice of site. An essential prerequisite to any construction is a good source of materials, but Louisbourg and its environs are not blessed with a wealth of natural resources. While supplies of sandstone, gypsum for plaster and limestone for mortar are all to be found elsewhere on the island, the French added to their difficulties by locating their principal establishment just about as far away from such sources as they could. Lumber, too, was constantly in short supply, good stands of timber being rare and hardwood virtually non-existent. Because of easy access to the sea, the builders of Louisbourg came to rely more and more on materials imported from other centres for their requirements: bricks and lumber from New England, sandstone, ornamental limestone and building hardware from France.[19]

Choice of site was thus less than ideal from a purely construction point of view. The inadequacies of the site in military terms have already been discussed. In light of our assessment of the defences and the main events of the two sieges, are we able, with the advantage of hindsight, to identify fundamental errors or omissions in the design of the fortifications? The application of a polygonal figure -- and hence a bastioned trace -- to the contours of the terrain made the low hills that were incorporated as bastions a logical choice, assuming that the decision to settle Louisbourg was irrevocable. It has been suggested that the other side of the harbour on the high ground above Lighthouse Point would have been a better military choice since there was no commanding ground in the immediate area,[20] but such a position is not tenable. Viewed from the harbour shore or from the road, the high ground appears to offer a secure location, but in fact the approaches from the north are furrowed with high ridges and gullies providing natural trenches along which whole armies could advance under perfect cover. Moreover, there is no easy communication with the shore or the hinterland; anyone attempting to defend it would be easily cut off and starved into surrender. Nor, from the commercial aspect, could an adequate quay front be established.

Commanding ground is not necessarily fatal if it can be controlled. Vauban characteristically took advantage of undefended ground when besieging a place, but was always careful to control the same ground with detached works when improving the defences of the captured town, which could never be taken by the same tactics he had used. The sieges and subsequent additions to the defences of Besançon and Luxembourg are classic examples. No attempt to remedy the problem of the commanding hills around Louisbourg ever got beyond the proposal stage.

There was, perhaps, some justification for this prior to the first siege: an approach overland by siege artillery was considered impractical. Ironically, such an opinion seems to have been encouraged by St. Ovide, who in his obsessive concern to ensure the complete protection of the harbour, felt that the landward defences could look after themselves. Complaining to the minister that Verville was wasting his time on the *enceinte* rather than concentrating on the harbour batteries, he successfully brought about a revision of priorities. His assessment of the landward defences is worth citing:

> Up to the present, work has concentrated on building a bastion to defend against a landward attack, which could only come about once an enemy had landed in the harbour, and this would be impossible today if construction of the harbour batteries had been begun first....;

these batteries would oblige an enemy to land down the coast in Gabarus Bay and from there

> he would be absolutely incapable of carrying out [an attack on the town] because the only access is by way of mountainous slopes; over rocks; and through swampy forests which are almost impassable even to the local inhabitants, who can only get through with difficulty.[21] (Author's translations.)

To what extent Verville concurred with St. Ovide's evaluation of the situation is not known, but he certainly never recommended any detached works, nor did he express any concern over the potential danger from the nearby hills. Verrier, responsible primarily for carrying out the construction of the fortifications according to his predecessor's designs, was similarly unconcerned with any problems beyond the foot of the glacis. We have already encountered his condescending tone in finally preparing plans to build, if the minister should so order it, a simple *lunette* in front of the Dauphin Gate "to relieve the governor's fears."

While the fears in question were expressed by Governor Duquesnel, the issue had been raised previously, probably by the obsessively cautious St. Ovide:

> A counterguard must be built in front of the Dauphin Gate, this gate being completely exposed ... this counterguard will besides augment the harbour defences and prevent an enemy setting up a position in the area of Martisan's property.[22] (Author's translation.)

The accuracy of the prediction requires little comment. In view of the damage inflicted on the gate, the Circular Battery and even the right flank of the King's Bastion by Titcomb's Battery, established on the "hauteur des Martissan" in 1745, it is interesting to speculate on the outcome had the counterguard been built. Aggressive fire could have kept the besiegers from establishing both Titcomb's and the advanced batteries, while the structure would have screened the gate area from the worst bombardment.

Perhaps the most caustic criticisms of Verrier's capabilities came from the *commissaire-ordonnateur*, Bigot, following the first siege. The gate, he said, was no stronger than that of a country house and Verrier's only justification that

> he only made [the walls on either side of the gate] and the Dauphin Gate itself strong enough to resist musketry fire; I wouldn't have believed that it was acceptable to incur such expenses in the name of the king to protect merely against musket shots.[23] (Author's translation.)

If Bigot reported Verrier's statement accurately, we must conclude that the attitude expressed as early as 1723 by St. Ovide prevailed, and that there was a general air of confidence shared by engineers and governors alike that no artillery attack need be expected from overland. It is scarcely likely that Bigot was unaware of this, although he was careful to disclaim all knowledge after the event.

Concerned above all with the security of the harbour, St. Ovide was by extension concerned with the security of the Royal Battery. It appears that he foresaw the potential threat from the rear, where the defences were light and, again, nearby, commanding hills offered an advantageous position to an attacker: the same prescient memorandum in which a counterguard was deemed necessary for the Dauphin Gate indicated the need of a redoubt on the hill above the Royal Battery.[24]

Control of the battery was an essential element of the 1745 siege. The French failure to defend it and the consequences of their precipitate retreat have already been discussed. Strategically, the error lay in the design, which concentrated the defences to seaward. That the engineers failed to take sufficient heed of the problem, even after it had been pointed out, proved to be a serious miscalculation. Muller seized upon the contemporary event to illustrate theories:

> There is generally another fault committed, which is, that if these forts or batteries are left open behind, or are very little fortified towards the land; the enemy may land men in the dark and surprise them.... The same thing happened last year at Cape Breton, where the French had a battery of 15 large pieces of canon which the English surprised in the dark, and turned the canon against the place, whereby they became soon masters of it.[25]

What is surprising is the degree to which the French were unable to benefit from the lessons of the first siege. Most of Franquet's efforts were expended on the ramparts of the landward *enceinte*, and his project for improving control of the approaches and commanding heights were not authorized. More seriously, little was done to improve the situation at the Royal Battery, with the result that the work was again more of a liability than a vital element of the defence once a landing had been effected.

Franquet's project for establishing redoubts in front of the Dauphin Bastion and on Black Rock was not unduly ambitious, consisting as it did of extending the existing line of fortifications no further than the range of musketry, with well-protected communications connecting directly to the main works (Fig. 89). The shortcoming of the redoubts, especially the one in front of the Dauphin Bastion, would have been that, anchored to the *enceinte*, they would not achieve command of more than the immediate environs and would have been subject to the same bombardment as the bastion behind them. The redoubts would have come into their own if an enemy attempted a direct approach, but would have been no deterrent to the establishment of siege batteries. In describing the various fronts of fortification, Franquet frequently mentioned the ground immediately beyond the glacis and the natural defence of the bog; with the flanking fire from the redoubts, he felt, an attack would be unlikely to succeed.[26]

The mine gallery under the glacis, Verrier's lack of concern for any additional outworks, and Franquet's confidence that no effective siege trenches could be dug in the boggy terrain all point to the conclusion that the engineers felt themselves well prepared to resist a "siège en règle" and its precisely laid-out parallels and saps systematically drawing closer to the foot of the glacis. They seem almost to have fallen victim to the efficiency of their own training. To the Corps of Engineers, siegecraft had become a highly refined art practised with surgical precision according to well-defined rules and timetables derived from estimates originally prepared by Vauban. Only a regular siege conducted according to their rules could succeed and the terrain would not permit one: therefore the fortifications could withstand an attack even in the unlikely event that an enemy could bring artillery into action on the landward side.

If that was their reasoning, the outcome of the first siege should have disabused them. True, Franquet wished to command the nearest heights, but even so, he gave no consideration to the hills around the Barachois and to Green Hill, which was well within range. The poor results obtained by the New Englanders' battery on Green Hill in 1745 should not be taken as a general indication of the effective range of siege artillery; it reflected rather on the quality of that particular artillery and the gunners. Fire from the King's Bastion actually dismounted one of the Green Hill guns -- no mean feat considering that the besiegers were having difficulty hitting the walls at that range (ca. 1500 m).[27] The ring of British batteries in 1758 is more indicative of effective range.

In retrospect, Green Hill appears to have been the key. In both sieges it was a most effective assembly point and location for opening the artillery bombardment. From there an advance to left or right could be made, bringing artillery into forward positions, making optimum use of natural cover and hence digging the minimum of trenches. How would things have gone had the French themselves controlled Green Hill? Although it is itself commanded by the ridges to the northwest, the range is extreme. More important, it was one thing to land artillery on the beaches and drag them over the low swampy ground to the Green Hill position, but would have been quite another to manoeuvre them up into the higher ground beyond. Green Hill is at a natural crossroads. The low, open ground extending towards the coast curves around the hill, running in one direction along the harbour shore and in the other to Black Rock. In the second siege the frigate *Aréthuse*, anchored in the Barachois, effectively held up the British advance by commanding these approaches; from a position on Green Hill, the command is superb. Rising above the "Plaine de Gabory," the hill's slopes provide a natural glacis for any fortification on its crest. Had the French invested less in the Royal Battery and instead built a powerful little fort on Green Hill, the whole land attack might well have been thwarted.

Such a fort would have been in the true Vauban tradition. One thinks of Mont Chaudane above Besançon or, more appropriately, of the forts on the heights on either side of the small Mediterranean port of Collioure, near the Spanish border (Figs. 249, 250). However, prior to the first siege, the necessity did not appear to exist, and afterward, considering the fate of Franquet's projects, it seems unlikely that such a proposal would have been accepted even if it had been made. As the withdrawals from the Royal Battery and the coastal defences around Kennington Cove demonstrated, the troops' ability to conduct a spirited resistance in a detached position was limited. Perhaps this justified the early rejection of Franquet's redoubts: "the troops which at all times have been garrisoned here can never be compared with the old-established infantry of France as far as defending a place is concerned...." (author's translation) wrote Rouillé in his letter rejecting any advanced works.[28]

Much has been made of the condition of the masonry as a contributory factor to the fall of Louisbourg. Was this, too, a reflection on the engineers' capabilities? The design of the fortifications and many of the buildings clearly did not take sufficient account of the climate, but to maintain that there was no construction season and the walls fell down as soon as they had been built[29] is oversimplification. Normally, construction can be carried out from mid-May to mid-October, while the problems of maintenance first began to manifest themselves with the parapets and embrasures a few years after construction. Use of beach sand still retaining a high salt content has been blamed for the failure of the mortar to set, largely perhaps on the basis of Franquet's speculations,[30] but the need for properly preparing sand for mortar was well known, as several treatises note and as Verville was careful to specify in his original *devis*.[31] The source of the trouble seems to have been in the small, irregular stones used for most of the construction, combined with the length of time required for lime mortar to set in a region of constant fogs, high humidity and driving rain. Once moisture has penetrated the joints -- or has never left them -- the effects of freezing temperatures are devastating. Naturally these first became evident on the most exposed areas, the parapets.

Archaeological excavation of the fortifications has demonstrated that under certain conditions the masonry was solidly built and able to withstand the combined ravages of climate, time and man, the most striking examples being the casemates of the King's Bastion, the powder magazine of the Dauphin Bastion, and the quay wall. The casemates and the escarps to which they were attached owed their survival primarily to the massive interior partition walls which acted as buttresses. If Verville had been allowed to continue with his idea of placing casemates behind all the escarps of the King's Bastion, all the walls would have been better preserved. As it was, the lack of interior buttresses caused the escarps of the faces to deteriorate badly, a problem Franquet recognized but was unable to rectify.

Approaching the problem from another direction, Verrier and Boucher were fully conscious of the shortcomings of the mortar and were able to devise the thoroughly practical, if unconventional, solution of encasing the walls in planks which acted as forms behind which the masonry could set firm. Franquet recognized the virtue of this technique, as his rebuilding of the right flank escarp of the King's Bastion testified. The extensive use of turf on the parapets and merlons was another inelegant but workable solution. It was never their intent or hope to built maintenance-free walls; a regular maintenance schedule was an essential prerequisite of sound defence. In using Medusa cement rather than lime mortar, the engineers responsible for the modern reconstruction of Louisbourg have reduced, rather than eliminated, the problem. Less than 20 years after construction, large cracks have appeared in the masonry and embrasures are being forced by frost action away from the parapets in which they are set. Climatic conditions caused and are causing unending maintenance problems.

In siege warfare as it had come to be practised in Europe in the 17th and 18th centuries, no place was expected to last indefinitely against an enemy. Fortresses presented a series of barriers to invading armies and served as bases for friendly armies. The ability to wage war successfully depended on the tactical disposal of armies in relation to fortified places: the campaigns of Marlborough (1702-10) are the classic examples. Vauban himself was a strong advocate of *camps retranchés*, large fortified enclosures in the lee of a fortified place permitting an army to rest and renew its supplies in safety while retaining the flexibility of movement that was lost once the army moved into the place itself. Once an enemy had committed himself to the siege of one place or to advance along a particular route, forces from other places could be regrouped to relieve the siege and to attack in their turn. Fortresses and armies were thus interdependent.

In this form of warfare, Louisbourg could not participate. It had no neighbours and no friendly armies were within reasonable distance. The nearest and only equivalent was the French navy, and relief by sea was a forlorn hope. Given sufficient determination on the part of an enemy who managed to control the sea and set an army ashore, no real chance existed of help arriving from the outside or even of getting a message through to ask for that help.

Nevertheless, the fall of Louisbourg in either siege was not a foregone conclusion. In spite of the disadvantages of the location and the disrepair of the fortifications, resistance was spirited. In both sieges the effects of prolonged bombardment on the town and civilian population were as much a factor in bringing about a surrender as anything else. In the first siege the New England troops were becoming disenchanted, especially after the Island Battery fiasco, and could well have decamped in the face of another setback. The only practicable breach established was in the Dauphin Bastion. Although the King's Bastion, its right face and flank in particular, suffered badly, no assault on it was ever contemplated. Both in 1745 and 1758, Louisbourg held out unaided for more than six weeks after the enemy had landed, and even in comparison with the length of sieges in the European theatres of war, such resistance was creditable by any standards.[32]

War games may be devised to replay the events of both sieges, to speculate on the great "ifs" of history, in attempts to identify the crucial points in the campaigns. Could the defence have been more inspired? Should there have been more sorties, should the landings have been resisted more vigorously? Could the harbour shore have been held by better placement of redoubts and intelligent use of the ships available? On the other side, what steps could the besiegers have taken to achieve quicker results with less risk? Such speculations are irrelevant: the events speak for themselves. Forced into the historical limelight as a reluctant fortress, Louisbourg fell to besieging armies after resisting, alone and unaided, for much longer than could have been expected considering its many defects. More could not be asked.

In establishing a fortified town on a remote island in the Atlantic off the North American mainland, the French were extending into the New World the fortification concepts of the Old. Engineers, contractors, administrators and soldiers came with those concepts to reinforce the conceit that here was another corner of France. Inevitably, the search to understand Louisbourg's fortifications has led back along that route to the European origins of the bastioned system.

Louisbourg's defences, albeit simple and inadequate by European standards, were squarely in line with methods and theories dating back to Vauban and beyond him to the Italian engineers who served under Francis I. The bastioned system had dominated European military architecture for well over a century prior to Louisbourg's founding and was beginning to show signs of obsolescence. Conceived as a response to a medieval form of warfare, bastions provided the defence with an overwhelming superiority against an enemy attempting to break through the walls of a place by main force. Geometrically calculated flanking fire ensured that no area of the *enceinte* could be assaulted openly with impunity and no blind spots existed to be used as a refuge for miners attempting to topple the walls. But the very success of such a defence stimulated progressive improvements in siege tactics. An enemy, forced by the protruding configuration of the bastions and an impenetrable curtain of fire from the flank batteries to begin his attack from a considerable distance away from the walls, had to approach gradually, under cover, until such time as he could hope to establish a breach. In bringing siegecraft to its highest form, Vauban above all eliminated the advantage bestowed upon the defence by the system he himself had been at such pains to improve. In its original form the bastioned system depended for its success on a poorly armed, inadequately protected force coming into its fields of fire. It was an inherently supine, nonaggressive, form of defence that was no match for an enemy pushing forward well-protected trenches and siege batteries, especially with the improvements in artillery that occurred in the 17th century. In order to be effective, the passive defence of solid walls had to be combined with mobile forces on the outside. Toward the end of his career, Vauban stressed this repeatedly and began experimenting with different forms of fortifications, realizing the shortcomings of the basic bastioned design. Yet the medieval traditions died hard and Vauban's inventive curiosity was not perpetuated. Thus at Louisbourg the traditional, simple *enceinte* emerged, its defences essentially designed to deal with an enemy at close quarters. It is almost as if the engineers, so familiar with the rites of sieges warfare, felt that no attack was to be considered seriously until it approached the foot of the glacis.

The short life span of the town and the lack of development subsequent to its destruction and abandonment offered a unique opportunity to examine a bastioned system unmodified by the changing military requirements of later generations. The initial research objective -- to provide sufficient architectural detail of the fortifications to allow convincing reconstruction -- could not have been accomplished without first understanding the methods and theories that were the common currency of the French military engineers who built Louisbourg, then assessing in detail what their intentions were and what they claimed to have accomplished. Scrupulous though the engineers' records were and graphically impressive though their many plans and drawings are, no real dimension could be given to the emerging image of bastioned work without visiting and studying numerous existing sites in Europe. To study Louisbourg's defences, archaeological excavation was the sole means of grasping reality. Thus the three strands of documentary research, analogues in military architecture, and analysis of the excavated remains are inextricably interwoven.

The exercise of participating in a major reconstruction programme, far from being a limiting factor, resulted in more exacting research, detail for detail, than would have been the case had no requirement existed that structures should actually arise. In dealing with an archaeological site of an 18th-century European culture, an adequate understanding of the site can only come about through an examination of the architectural, documentary and material evidence of that culture as a whole and of the site in particular. This paper is offered as a contribution towards such an understanding.

Appendix A

Louisbourg: Construction Chronology

1713	Peace treaties of Utrecht: Acadia (roughly the area occupied by present-day mainland Nova Scotia and much of New Brunswick) and Newfoundland ceded to England. Loss of fortified base at Plaisance (Placentia, Newfoundland) compels French to seek new location on Isle Royale (Cape Breton Island).
1713-14	Three possible sites considered: Port Dauphin (Englishtown), Port Toulouse (St. Peters) and Louisbourg. Indecision as to which would be principal establishment, but tendency to favour Port Dauphin.
1715	Residences and temporary fortifications begun at Port Dauphin.
1716	Verville sent out as director of fortifications responsible for organizing defence of colony.
1717	Emphasis switched to Louisbourg as principal establishment.
1718	Designs begun on King's Bastion. Contractors engaged.
1719	Louisbourg confirmed as permanent capital of the colony. Construction of King's Bastion begun.
1720-23	Construction continued. Preliminary plans for Royal Battery drawn up.
1724	Verrier sent to Louisbourg as chief engineer.
1725	Verville recalled. Contract on Royal Battery awarded, construction begun.
1726-27	Barracks building occupied by governor; work continued on soldiers quarters. Work continued on Royal Battery; work begun on Island Battery. Designs of Dauphin Half-Bastion submitted.
1728	Work continuing on batteries. Dauphin Bastion construction begun.
1729	Dauphin Circular Battery and escarps complete, gate and powder magazine under construction.
1730	Work resumed on rest of landward defences; designs prepared and submitted.
1731	Parapets and terrepleins of the ramparts reportedly finished on King's Bastion. Curtain walls to Queen's and Dauphin bastions begun. Island Battery completed.
1732	Royal Battery completed.
1732-34	Work continuing on landward defences: Queen's and Princess bastions, curtain walls. Dauphin Gate completed.
1735	*Eperon* on quay in front of Dauphin Bastion constructed.
1736	Governor St. Ovide proposed new defences across Rochefort Point. Parapet and embrasure repairs to Island Battery.
1737	Plans prepared for new works. Ramparts and parapets on landward defences completed, counterscarp and ditch finished, glacis and covered way in progress. Excavation begun on ditch of new works at Rochefort Point.
1739-42	Construction concentrated on Rochefort Point fortifications: Brouillon and Maurepas bastions, Pièce de la Grave. Outworks of landward defences completed. Quay construction begun.
1743	Fortifications declared complete. Work continuing on quay.
1744	Remaining work on quay completed.
1745	First siege: Louisbourg taken by volunteer army from New England supported by British navy.
1745-49	British occupation. Makeshift repairs to worst-damaged areas: right flank of King's Bastion, Dauphin Bastion and Gate area. Cavalier erected on Dauphin Bastion, wooden barracks erected in Queen's Bastion.
1748	Treaty of Aix-la-Chapelle: Louisbourg to be returned to France.
1749	Departure of British garrison; return of French.
1750	Arrival of Franquet to oversee fortifications of Isle

	Royale and later (1754) of all New France. Urgent repairs carried out.
1751	Various proposals put forward for improving the defences and adding detached works.
1752	Repairs to Pièce de la Grave, damaged by winter storms.
1753	Plans for *demi-lune* and *contre-garde* drawn up.
1754-56	Tenaille built across pond in front of King's-Dauphin curtain, *contre-garde* built parallel to right face of Princess Half-Bastion, *demi-lune* built in front of Queen's-Princess curtain. Alterations and repairs to outworks of landward defences. Right flank of King's Bastion rebuilt. Repairs to Dauphin Bastion, including improvements to cavalier. De Salvert's battery established at the tip of Rochefort Point.
1756-57	Field fortifications established around likely landing areas to north and south of Louisbourg. Earthworks and turf revetments added to most vulnerable area of King's Bastion. De Salvert's battery extended.
1758	Second siege: Louisbourg taken by British naval and army expedition.
1759	Louisbourg as base from which British attack on Quebec City and conquest of Canada was launched.
1760	Fortifications systematically demolished.

Appendix B
The Franquet *Mémoires*

In assessing what work Franquet felt was necessary to put Louisbourg's fortifications in an acceptable state of defence, it is convenient to think in terms of two alternative proposals: construction of appropriate detached works and outworks to achieve an ideal fortification regardless of expense, and, more pragmatically, a minimum of repairs to the existing defences simply to make them functional. In fact, each front was considered on its merits, and major or minor improvements set forth section by section. The various permutations of these are numerous. The weakest areas of the landward *enceinte* obviously drew the greatest attention, in particular the King's-Dauphin front. Various proposals called for a *demi-lune* in the pond in front of the curtain, a redoubt on the lime-kiln hill in front of the Dauphin Half-Bastion and, more grandiosely, a total rebuilding of the whole Dauphin Half-Bastion and its outworks. Similar projects were also contemplated for the Queen's-Princess front. Examination of the plans gives some idea of the scope and complexity of several of these projects (Figs. 89, 94). Franquet's proposals merit a detailed study in their own right, more than can be accorded in the framework of the present paper; however, of direct relevance to an understanding of what was actually built are the sections *(profils)* through the ramparts drawn to accompany his minimum recommendations (Figs. 90-93). The drawings purport to show, by means of colour coding, the fortifications as they were when Franquet first inspected them (in 1751) as well as proposed improvements. Of particular interest is the fact that this was one of the rare instances when actual dimensions were indicated on drawings rather than leaving the matter open to the imprecise method of scaling from the small, crude scale invariably included. Unfortunately, Franquet's drawings are more representational than accurate, and the small scale and combination of actual features with proposed construction renders interpretation difficult. The issue is further complicated by the fact that dimensions marked on what was supposed to be there do not always agree with other evidence, either documentary or archaeological.

Immediately apparent is the absence of a cordon or separate, vertical parapet above the inclined escarp although the heights indicated make it clear that the parapets were included and that the measurements were not taken at the top of the escarp. There is thus no way of determining the height of the escarp alone -- and hence the height of the parapet -- without projecting the alignment of the rampart terreplein through to the exterior of the escarp and resorting once again to scaled dimensions. In some instances Verrier had designed his parapets to be extensions in the same plane as the escarps, notably on the new *enceinte* at Rochefort Point, but all evidence points to vertical parapets on at least the King's Bastion. We must assume that Franquet was not concerned with such detail and simply wished to convey the overall height of the ramparts he was working with. His drawings are therefore of little help in determining the precise configuration of escarps and parapets in the areas where other evidence is scarce, notably the curtain walls. Franquet's preference for sloping, turf-revetted parapets is reflected backwards in time, as it were, onto all the earlier ramparts.

The interior revetments of the faces of the King's Bastion are depicted as at least twice as thick as excavation proved them to be, and they are shown with a pronounced batter, whereas they were found to have been built vertical in accordance with Verrier's specifications, despite the colour coding which suggested that the walls were as Franquet found them.

The plans which accompany the profiles and are the keys to the location of each profile all bear notations which begin:

> The first proposal simply corrects faults in the fortifications, suggesting additions to and not destruction of the earlier works, which would make each of the four landward fronts equally strong. The thickness of

> sections which were too feeble to resist cannonfire is to be increased....[1] (Author's translation.)

Despite the use of red and yellow colouring (the red appears as the darker line on the black and white prints) indicating two levels of parapets, banquettes, terrepleins and slopes of the ramparts, it cannot be assumed that the underlying red lines all accurately represent existing structures.

Appendix C
Calculations to Determine the Original Elevation of the Terreplein of the King's Bastion Ramparts

1. Adding Material Removed to Surviving Casemate Elevations. As recorded in 1962, the right flank casemates were approximately 1 ft. (30 cm) higher than those on the left. Either the original structures were not at the same level or the 1903-04 restoration work had removed more material from the top of the left flank than from the right. There is no precise way of testing either hypothesis; however, photographs taken at the turn of the century show that the material covering the arches of the right flank casemates was considerably thicker than that over the left flank casemates when the escarp was stripped away (Figs. 105, 108). The conclusion is therefore that more material had been removed from the left than from the right. All we know of the material removed is that it was "about the thickness of three feet." If this amount had been removed from the left flank, then less would presumably have been removed from the right. Conversely, if three feet had been removed from the right, then more must have been removed from the left. The elevation range is thus between 51.8 ft. (15.79 m) and 52.8 ft. (16.09 m). See Table 1.

2. Adding Material Specified in Original *Devis* to Surviving Casemate Elevations. Verville's original design was not carried out. Dimensions were changed and the two long *souterrains* paralleling each flank were replaced with casemates at right angles to the escarps. The construction techniques specified in his 1718 *devis* nevertheless conformed to standard practice as exemplified by Belidor. It is clear that casemates required a substantial amount of fill over them to aid drainage and to protect them from mortar-bomb damage. Belidor recommended 5 or 6 *pieds* of earth on top of vaults at least 3 *pieds* thick. To allow proper drainage, the tops of the vaults were carefully mortared to form what was hoped to be an impermeable layer, and then layers of gravel and larger pebbles built up to form a bed for the earth fill.[1] It is this technique that Verville specified, paying careful attention to the time required for the soil and moisture to consolidate between the various stages: one month for the first layer, two weeks for succeeding ones.[2]

Table 1. Casemates

	Left Flank		Right Flank	
Average height in *toisés* to top of arch	17 *pieds* 18.66 ft.	6 *pouces* (5.69 m)	26 *pieds* 27.72 ft.	(8.45 m)
Average elevation of partition wall foundations	32.18 ft.		22.75 ft.	
Combined Total	50.84 ft.	(15.5 m)	50.47 ft.	(15.39 m)
Maximum elevations as recorded in 1962	48.8 ft.	(14.87 m)	49.8 ft.	(15.18 m)
Add "thickness of three feet" removed in 1903	51.8 ft.	(15.79 m)	52.8 ft.	(16.90 m)

A change of design would not have caused any modification to this technique, which would have been desirable whatever form of casemates were built. The problem comes in trying to determine where the minimum of 2 *pieds* of gravel would have been measured from. If it were laid in the troughs between the arches and measured from the lowest point, it would barely cover the top of the arches. On the other hand, if it started at the high point of the arches, then the level of the rampart terreplein would be raised by 2 *pieds* plus whatever additional material was laid on top of the gravel. The free-stone platform, the stones of which were an average of 18 cm thick, together with sufficient sand or mortar in which to set them, represent a minimum thickness of additional material. The profile accompanying Verrier's 1725 proposals (Fig. 115) indicates a layer of fill between the free-stone platform and the top of the casemate arch; however, the same profile is shown on the 1730 plan with the stones practically on top of the arch (Fig. 119). Although measurements scaled from these plans are of dubious reliability at best, the thickness of the arch in both cases appears to be the same -- somewhat in excess of 4 *pieds*, a dimension compatible with the measurements of the surviving arches on the right flank.

Accepting the later plan as a more accurate representation of the work Verrier intended to do the following year, we may postulate a construction method whereby the bulk of the gravel was deposited in the troughs between the arches and brought up to the tops of the arches, where a final layer covering the vaults entirely was laid to a sufficient depth to provide a good bedding for the platform stones. We can only guess the thickness of such a layer. No paving stones were found in place in 1903, none show in the admittedly poor and scarce photographs of the time, and none were built into the restored work anywhere. It is highly unlikely that a valuable source of building material in such an exposed position would have remained unsalvaged for over a century. To the fill above the casemates, then, must be added the thickness of the platform at minimum. The range thus would be from 18 cm (thickness of stones) to 65 cm (thickness of stones plus 2 *pieds* of gravel).

3. Adding *Toisé* Average Heights to Known Base Elevations of the Escarps. Because of the uneven nature of the terrain, precise calculations cannot be made. For three of the four escarps, a single average height of masonry used was estimated in each case. However, archaeological investigations of the foundations revealed considerable variation in the elevations of the base. Averages of these base elevation were therefore made from different points along the walls, and the averages added to the *toisé* averages to give the elevation at the top of the escarp.

In the case of the fourth escarp -- the right flank -- two masonry averages were given. Since the larger amounts must have been used to build in the pronounced hollow identified archaeologically in this area, two averages were therefore calculated for the base elevations.

The results of these calculations are given in Table 2.

Table 2. Escarps

Left Flank		
Spot elevation	29.55	
	27.55	
	28.00	
	32.17	
	31.66	
Total	148.93 ft.	
Average elevation	29.79 ft.	(9.08 m)
Historical average	19 *pieds*	6 *pouces*
	20.79 ft.	(6.34 m)
Combined Total	50.58 ft.	(15.42 m)
Left Face		
Spot elevation	30.75	
	32.16	
	33.41	
	31.16	
	33.80	
Total	161.38 ft.	
Average elevation	32.28 ft.	(9.84 m)
Historical average	16 *pieds*	6 *pouces*
	17.59 ft.	(5.36 m)
Combined Total	49.87 ft.	(15.2 m)

Right Face

Spot elevations	29.33	
	32.80	
	34.75	
	30.25	
	27.25	
Total	154.38 ft.	
Average elevation	30.88 ft.	(9.41 m)
Historical average	20 *pieds*	6 *pouces*
	21.85 ft.	(6.66 m)
Combined Total	52.73 ft.	(16.07 m)

Right Flank: Average 1*

Spot elevation (Regular foundation)	24.00	
	23.83	
	23.00	
	24.75	
	27.00	
Total	122.58 ft.	
Average	24.52 ft.	(7.47 m)
Historical average	24 *pieds*	(7.80 m)
Combined Total	50.10 ft.	(15.27 m)

Right Flank: Average 2*

Spot elevations (Low section)	22.75	
	21.17	
	20.50	
	21.00	
	22.83	
Total	108.25 ft.	
Average	21.65 ft.	(6.60 m)
Historical average	28 *pieds*	(9.10 m)
Combined total	51.5 ft.	(15.7 m)

*Because a large section of the wall was located in low-lying ground, two separate averages were calculated in the *toisé*, hence two averages were calculated on the elevations of the base.

The resultant final elevations are lowest where bedrock was highest. As the bedrock sloped from the side of the ditch up to a high point within the bastion near the flanked angle, a wall would have a considerably shallower foundation on the inside than a reading at its base in the ditch would suggest; thus the archaeological average elevations are if anything a little low, being taken in all cases on the ditch side. This is especially true in the case of the left face and the left flank. The range is from a low of 49.87 ft. (15.2 m) to a high of 52.73 ft. (16.07 m).

4. Adding *Toisé* Average Heights to Known Base Elevations of the Interior Revetments. The interior revetments being much thinner than the escarps, there was no problem in discrepancies in cross-section; however, along the entire lengths of the walls considerable changes in elevation were observed, especially on the right face. The drop was so pronounced from the flanked to the shoulder angle that two averages were given in the *toisés*, and hence two average elevations were calculated. The results are given in Table 3.

The highest combined total was on the left flank, but no ready explanation for this can be given. The low reading on the right face is understandable in light of the sharp drop in elevation near the shoulder angle. The range is thus from a low of 48.13 ft. (14.67 m) to a high of 54.05 ft. (16.47 m).

5. Adding *Toisé* Average Heights to Known Base Elevations of Casemate Partition Walls. Applicable only to the flank casemates, the *toisé* heights were given from the foot of the walls to the spring of the arch, and then to the top of the arch. A single average is given for each flank, both historically and archaeologically. The deduced elevations thus give the full range: 50.47 ft. (15.39 m) to 50.84 ft. (15.5 m). See Table 1.

Interpretation and Conclusions

The extreme range of deduced elevations is from 48.13 ft. (14.67 m) to 54.05 ft. (16.47 m). As each area has its limiting factors, an average based on all deduced elevations would not advance the situation meaningfully. Instead, we should examine the terrain and attempt to determine where the most reliable calculations may be made. The right flank casemates offer the best possibilities because their partition walls were all at a reasonably uniform level, hence less variation is likely to arise in adding an historical average to an actual elevation or an average elevation based on readings in each casemate. In addition, elevations from the surviving

Table 3. Interior Revetments

Left Flank		
Spot elevation	33.95	
	32.66	
	31.25	
	33.00	
	35.45	
Total	166.31 ft.	
Average elevation	33.26 ft.	(10.14 m)
Historical average	19 *pieds*	6 *pouces*
	20.79 ft.	(6.34 m)
Combined Total	54.05 ft.	(16.47 m)
Left Face		
Spot elevation	36.50	
	34.50	
	39.27	
	37.83	
	40.33	
Total	188.43 ft.	
Average elevation	36.69 ft.	(11.49 m)
Historical average	12 *pieds*	
	12.79 ft.	(3.9 m)
Combined Total	50.48 ft.	(15.39 m)

Right Face

	High Section		Low Section	
Spot elevation	38.00		27.55	
	37.43		27.95	
	37.30		28.55	
	36.40		29.50	
	35.50		31.16	
Total	184.63 ft.		144.71 ft.	
Average elevation	36.93 ft.	(11.26 m)	28.94 ft.	(8.8 m)
Historical average	15 *pieds*		18 *pieds*	
	15.99 ft.	(4.87 m)	19.19 ft.	(5.85 m)
Combined Total	52.92 ft.	(16.13 m)	48.13 ft.	(14.6 m)

Right Flank

Spot elevations	22.16	
	23.58	
	20.60	
	21.59	
	23.42	
Total	111.35 ft.	
Average elevation	22.27 ft.	(6.79 m)
Historical average	26 *pieds*	
	27.72 ft.	(8.45 m)
Combined Total	49.99 ft.	(15.24 m)

arches offer another means of comparison. The close correlation between the deduced elevations and the as-found elevations should be noted.

While the partition walls of the left flank casemates were deeper towards the escarp than towards the interior revetment, the uniformity of slope allowed for reasonably accurate averaged elevations to be calculated. Again, the correlation between deduced elevations and as-found elevations is close, especially if the "three feet" of Kennelly's work is added. Both sets of casemates produce final elevations that correlate closely to each other.

Based on the above calculations, the vaults of the casemates appear to have been waterproofed -- albeit unsuccessfully -- and covered with a layer of fill to just above the highest point of their arches. The elevation above present mean sea level of the finished surface could not have been below 50.5 ft. (15.39 m) and may have been as much as a foot higher. To this Verrier later added a platform of sandstone slabs some 18 cm thick to form a watershed, the ridge running along the central row of stones. Allowing for sufficient material in which to set the platform, the elevation of the rampart terreplein corresponding to the top of the cordon, or magistral line, must have been in the neighbourhood of 51.5 ft. (15.7 m)

Appendix D
The Relationship between the Slope of the Glacis and the Superior Slope of the King's Bastion Parapets

Extending the slope measured on the glacis in front of the right face and incorporating archaeologically established elevations on the covered way, the hypothetical section M-M can be established through the entire right face (Fig. 131). The extension of the slope passes 1.6 m above the cordon if the latter be placed at 15.7 m ASL (see Appendix C for the derivation of this elevation). The vertically extended plane of the interior revetment of the parapet is intersected at 18.14 m ASL. If this point be taken as representing the superior crest of the parapet, then the total height above the presumed rampart terreplein level would be 2.44 m. Assuming a standard banquette, the firing height above the tread of the banquette would be 1.46 m. Such dimensions correlate almost exactly with the typical banquette and firing height of 3 *pieds* (0.98 m) plus 4 *pieds* 6 *pouces* (1.46 m) recommended by 18th-century military authorities. The recommended total height of the crest above the rampart terreplein of 7 *pieds* 6 *pouces* (2.44 m) also coincides.

As noted earlier, the extended slope passes 1.6 m above the assumed cordon height. This would result in an exterior revetment of the parapet approximately 5 *pieds* high, which falls within the 3.5- to 6-*pied* range recommended.

It would be gratifying to report that a similarly close correlation was established for the left face parapet and glacis, but such was not the case. The projected slope of the glacis passed less than a metre above the hypothetical elevation of the magistral line. Assuming a parapet of similar dimensions to that of the right face, this meant that the prolongation of the glacis slope fell 46 cm below the presumed top of the exterior revetment.

Considering the number of variables in the situation, there is no valid method of calculating the parapet height and slope to finer tolerances. Some of the assumptions are inherently unprovable: that the magistral line was indeed horizontal, that the parapets of both faces were uniform, and that the glacis (and superior slopes of the parapets) were geometrically precise within tolerances of 1 *pied* or less. Nor should we overlook the fact that the derived elevation for the cordon is just that: a calculation, also susceptible to some variance.

The negative evidence favouring any change in elevation along the magistral line -- the absence of any comment in Boucher's estimates or Franquet's inspection report -- has already been discussed (see "King's Bastion: Parapets, Embrasures and *Guérite*"). The same evidence favours a uniform parapet height. Boucher's estimates are based on a standard 5-*pied* average height for all the parapets in need of repair, which implies a degree of uniformity.

The figure of 5 *pieds* should be accepted with some qualification. It is an averaged height ("hauteur réduit") used for establishing quantities of masonry required by volume. In a not completely rectangular wall, the averaged dimension is thus only an actual measurement at a specific midway point: on either side of that point, the wall is of greater or lesser dimensions. An escarp, for example, would have a batter to its outer face so that the base would be wider than the top. In the calculation tables prepared by Belidor, a 30-*pied*-high wall with a one-in-six batter should be 11 *pieds* 5 *pouces* thick at the base and only 6 *pieds* 5 *pouces* thick at the top. Thus an averaged thickness used for calculating the total amount of masonry required would not be a useful indicator of the thickness of the wall at the top or bottom unless the total height and degree of slope were also known.

In the case of the parapets, the 5 *pieds* cannot be taken to represent the height of either the exterior or interior revetment, but of a point midway between.

On the right face, prolongation of the glacis would result in a parapet with an exterior revetment 1.6 m high (roughly 5 *pieds*), and on the left the line of intersection was no more than 46 cm above the cordon (1.41 *pieds*). The one calculation is somewhat high, the other certainly too low.

Franquet's pofiles show no distinction between escarps and parapets, but seem to refer to total heights of surviving masonry. For the left face, a total height of 23 *pieds* 4 *pouces* (7.58 m) is given; if to this is added the average elevation established in the field for the base of the wall (9.84 m), an elevation of 17.42 m is reached. The deduced elevation for the cordon is 15.7 m, the difference of 1.72 m representing the possible parapet height (exterior revetment height above cordon). On the right face, Franquet has given a lower total height of 21 *pieds* (6.83 m). The average elevation for the base of the right face escarp was 9.41 m, so that an elevation for the exterior crest of the parapet would be no more than 16.24 m. Subtracting the deduced cordon height, the resulting 54 cm would be the presumed height of the parapet's exterior revetment.

By approaching the problem from another direction, the impression that the left face parapet was lower than the right has been reversed. This apparent confusion may be reduced, if not eliminated, when we recall that there was a considerable slope of the foundation from the flanked angle down towards the right shoulder, thereby producing a low average reading; however, a section of the wall was directly located on an outcrop of bedrock, raising the foundation there to an elevation well above average. The plan of the fortification front indicating where Franquet's profiles were taken shows that the profile across the right face was taken at the bottom of the ramp leading from the interior of the bastion up to the rampart. In this area the foundations were at an elevation of 10.5 m. If Franquet's height of 21 *pieds* (6.83 m) is added to this, the resultant elevation of 17.33 m is much closer to the deduced elevation on the left face.

In summary, it is fair to postulate a height of between 3.5 and 5 *pieds* for the exterior revetment of the parapet. While the degree of slope of the glacis was clearly related to the parapet design, calculations based on the contours of a surviving feature from which the crest had gone and the tail was indefinable, and which had been disturbed, if indeed it was ever properly finished, cannot be expected to produce results of greater precision. Attempts to relate specific dimensions from historical sources to known elevations in the field have limitations beyond which a quest for precision becomes unrealistic.

Appendix E
Calculations to Determine the Dimensions of the King's Bastion Embrasures

Based upon the evidence of extant European examples and illustrations in fortification treatises, the identification of dressed stones which had come from embrasures was relatively straightforward. It merely remained to arrange the stones to reconstitute the form of the embrasures (see Figs. 144, 145). To provide an operating framework, two assumptions had to be made: that the embrasures on one flank, as depicted on Verrier's 1725 and 1730 proposals (Figs. 115, 119) as well as on later, post-construction plans, were all identical in design, thereby permitting details derived from one stone to be considered generally applicable to all the embrasures; and secondly, that the width of the parapet on the flanks was 9 *pieds*. This dimension is never specified in actual figures, but is scaled from the profile drawings on Verrier's proposals. It is the minimum width recommended by Chaussegros de Léry under normal circumstances (Fig. 251).

An embrasure typically comprises several intersecting planes as it flares from a constricted to a wider opening (Fig. 252). Thus the placement of a stone cut with faces to fit one or more of these planes is geometrically determined within narrow limits. Assuming that the exterior revetment was vertical, a stone cut to form part of the exterior crest, for instance, would have to have one face at 90 degrees to its horizontal bedding plane, its upper surface conforming to the superior slope of the parapet, and one side conforming to the cheek of the embrasure. It could fit in only one location. Two such stones were found, thereby indicating the angle of the superior slope.

Two sets of three stones each were identified as rear sills, located in the interior revetment of the parapet. They were cut to reflect the point at which the sole of the embrasure changed from a horizontal to a downward-sloping surface. The outer stones of each set were cut to conform to the constriction of the throat of the embrasure. Stones forming the throat itself were also found. Finally, several stones were identified as belonging to the front sill at the embrasure mouth; two were cut to fit the extremities where the planes of the sole, the cheek and the exterior revetment intersected. By placing the front and rear sills parallel to each other but 9 *pieds* (2.92 m) apart and adding the stones from the throat, sufficient lines could be projected to allow the width of the mouth to be calculated and to yield the overall dimensions of an embrasure in plan.

While the stones from the exterior crest indicated the assumed angle of the superior slope, and the front and rear sill stones indicated the slope of the sole, certain critical dimensions that would define the height of the embrasure were still missing. The relationship of the exterior crest to the front sill (the height of the exterior revetment) and of the rear sill to the rampart terreplein (the *genouillère* height) remained undetermined.

Various criteria derived from documentary sources could be applied to produce different permutations. If the total height of the interior revetment above the terreplein were 7-1/2 *pieds*, as on the faces of the bastion, then the angle of the superior slope would intersect the vertical face of the exterior revetment almost 5 *pieds* above terreplein level, comparable to the height shown on the Island Battery (Fig. 233). However, Boucher's repair estimates noted that the "hauteur réduit" of the masonry required for the flank parapets was 5 *pieds*.[1] If this is the averaged height of the merlons, used as a means to calculate total volume of masonry required, then a 9-*pied*-wide parapet would be almost 6 *pieds* high at the rear and only 3 *pieds* high at the front.

The height of the rear sill in relation to the front sill was governed by the degree of slope of the sole to which they both conformed; determining the vertical location of one sill would indicate the location of the other.

"EMBRASURES, are openings in the parapets, for firing cannon. The embrasure is 9 *pieds* wide nearest the country and 2 *pieds* 6 *pouces* wide on the interior or platform side."[2]

(Author's translation.) Assuming a *genouillère* height of 2 *pieds 6 pouces*, (.81 m) the slope of the sole would place the front sill somewhat above the level of the terreplein (cordon).

However, examination of the front sill stones revealed some unusual features: the outer face was cut at an angle rather than vertical to its horizontal bedding plane, implying that the wall in which the stones were set was not vertical. Either the exterior face of the parapet was not vertical or the sill was set below the base of the revetment. Verrier's proposals and the stones from the exterior crest both indicated that the revetment was indeed vertical. Typically, the front sill of an embrasure is set on the cordon (Figs. 45, 252). Such does not appear to have been the case here; the slope on the outer face was one in six, coinciding with the batter on the escarp, which suggested that the sills were set at the very top of the escarp, forming in effect the base course of the parapet. The thickness of the stones and the way in which the sides were carefully finished, as if to bond to other dressed stones rather than left rough to bond with rubble masonry, suggested that the sill formed part of the cordon course, which would be interrupted at each embrasure.

Among the many and varied styles of embrasure examined by the author, the relationship of the sill to the cordon as just described has not been observed. Could such a configuration have occurred at Louisbourg, and if so, why? Both the superior slope of the parapet and the slope of the sole of the embrasure were quite steep. On the assumption that, as for the parapets of the faces, an attempt was made to provide for a field of fire suited to the terrain commanded, such slopes are understandable. The right flank of the King's Bastion commanded a front that sloped from the flanked angle down to the harbour's edge in front of the Dauphin Bastion, a drop at ground level of over 10 m (Fig. 134). The parapets and embrasures of the right flank would therefore have to be designed to allow for such a drop. The intervening ditch, moreover, would have to be covered in order to eliminate dead ground in front of the curtain: it would be a ludicrous state of affairs to have an assault party in the ditch about to escalade the curtain only a few hundred paces away but immune from flanking fire because the guns could not be trained upon them. It was as a means of preventing this, after all, that the whole concept of flanking fire was evolved. While no precise figures are given in 17th- or 18th-century treatises, a 19th-century authority insisted that a point midway along the curtain, and within 4 feet of the bottom of the ditch, be exposed to the fire from both flanks of a fortification front in order to eliminate this potential source of embarrassment.[3] In designing the embrasures Verrier would have had to provide the soles with the steep slope indicated on the stones that were found, but the rear sill of the embrasures should nevertheless be within a reasonable height of the rampart terreplein in order to accommodate guns on carriages. He may have been obliged to incorporate the front sill in the cordon course to satisfy both criteria; however, in extending the slope of the sole as indicated by a front sill located at cordon level, the *genouillère* height falls somewhat below the 2 *pieds 6 pouces* specified. Evidence from the excavation of the Dauphin Bastion indicated that on the Circular Battery a *genouillère* closer to 2 *pieds* appears to have been used. If this indicates general practice at Louisbourg, as the profile through an embrasure of the Island Battery suggests, then a similar height, as geometrically required by the sill stone, is reasonable for the King's Bastion embrasures.

It follows that the left flank embrasures, while sharing many of the same characteristics, would relate to the local terrain in the angles of their slopes rather than be identical to those of the right flank. The ground on the front formed by the left flank of the King's Bastion and the right flank of the Queen's Bastion was much more level, a drop of only 2.4 m being recorded. Regrettably, the archaeological evidence concerning the embrasures on this front was not as comprehensive as that provided by the stones from the right flank of the King's Bastion. Only three stones that could positively be identified as having belonged to gun embrasures were found, all in the ditch with no possibility of determining chronological context. Two, near the left flank, were from the exterior crest, indicating in one case a superior slope that was 18 degrees to the horizontal and in the other a much more gentle slope of 8 degrees. The third stone, located at the base of the right flank of the Queen's Bastion, was from the front sill of an embrasure, but was cut to be placed in a vertical parapet -- hence, above the cordon course. Moreover, the slope of the sole was half that of the soles from the right flank of the King's Bastion.

The evidence, albeit fragmentary, supports the contention that each flank parapet was designed to accommodate the terrain it commanded, which raises another issue. The superior slopes of the left and right flanks appear to have been different, as well as the soles of the embrasures. In the case of a parapet with a banquette, the superior slope would obviously be directly related to the line of fire desired for musketry; however, the parapets of the flanks are, except for Verville's earliest proposals, depicted without banquettes and it scarcely seems probable that the parapets were no higher than 4-1/2 *pieds* at the rear so as to enable infantry to fire over them. But as the various sections through parapets illustrating Chaussegros de Léry's text show, the steepness of the superior slope is proportional to the width of the parapet: the wider the parapet, the gentler the slope. It is reasonable to assume, therefore, that the reworked stone fitting a superior slope of only 8 degrees came from a parapet much wider than the original 9 *pieds* in 1735.

Franquet apparently reduced the number of embrasures on the flanks and widened the parapets (Fig. 120). Moreover, if the superior crest in Verrier's design was to be at a constant height above the terreplein, then the superior slope on the right flank would have to be steeper because the embrasures, set at the level of the cordon, would necessitate a more rapid rise to the crest than on the left flank where the embrasures could have been set a course higher, on top of the cordon. This would have resulted in a slightly gentler superior slope, which difference is indicated by the stones from the exterior crest: 18 degrees from the left flank, 22 degrees from the right.

Such an argument assumes that the masonry exterior revetment of the parapet was uniform throughout the bastion, on the faces as well as the flanks. Whether the height of the interior revetment was similarly uniform would depend on how high above the *genouillère* the embrasures were built. Franquet's inspection report on the fortifications contains the enigmatic remark: "the left flank of the King's Bastion ... also has the defect of being higher than the left face of this [the King's] bastion...."[4] (Author's translation.) Could this mean that, viewed from the terreplein, the left flank parapet, lacking a banquette, appeared higher than that of the face? The right flank is not similarly described, but the New England forces had built a wooden platform on top of the terreplein, which would have effectively reduced the height of the parapet, viewed from the rear.

The evidence concerning the embrasures, and in particular the height above the rampart terreplein, both for the exterior and interior revetments, is inconclusive and in some cases conflicting. There are equal grounds for postulating a relatively low parapet, based upon European parallels and an interpretation of Boucher's "hauteur réduit," or a higher parapet such as Verrier illustrated on the Island and Circular batteries. Because of the steep superior slope required in accepting the stone from the exterior crest, a design incorporating a 5-*pied*-high exterior revetment would result in a correspondingly high interior revetment, such as has in fact been reconstructed on site. The hypothetical model presented in Figure 145 is based upon the minimum height suggested by Boucher's figures.

List of Abbreviations

AG	France. Archives du Génie (Vincennes).
AN	Paris. Archives Nationales.
APT	*Bulletin of the Association for Preservation Technology.*
BG	France. Ministère de la Défense. Bibliothèque du Génie (Paris).
BN	Paris. Bibliothèque Nationale.
CP	Cartes et plans.
CO	Colonial Office.
CTG	Comité Technique du Génie.
DFC	Dépôt des fortifications des colonies.
FLNHP	Fortress of Louisbourg National Historic Park, Louisbourg, Nova Scotia.
OED	*The Compact Edition of the Oxford English Dictionary.*
PAC	Canada. Public Archives.
PRO	Great Britain. Public Record Office.
RAI	Woolwich, Eng. Royal Artillery Institute. Library.
RUS	London. Royal United Services Institution for Defence Studies.
WO	War Office.

Endnotes

Gunpowder: Its Impact on European Warfare

1 Louis-Napoleon Bonaparte, Etudes sur le passé et l'avenir de l'artillerie (Paris: Dumaine, 1846-70), Vol. 2, p. 107.

2 e.g. Oliver Lyman Spaulding, H. Nickerson and John W. Wright, Warfare: A Study of Military Methods from the Earliest Times (New York: Harcourt, Brace & Co., 1925), Pt. 3, Chap. 1; Reginald Blomfield, Sebastien Le Prestre de Vauban, 1633-1707 (London: Methuen, 1938), p. 14; Christopher Duffy, Fire and Stone: The Science of Fortress Warfare 1660-1860 (Newton Abbot: David & Charles, 1975), p. 9.

3 J.R. Hale, "The Early Development of the Bastion: An Italian Chronology, ca. 1450 - ca. 1534," in Europe in the Late Middle Ages, eds. Hale, Highfield and Smalley (London: Faber and Faber, 1965), pp. 446-95.

4 L.-N. Bonaparte, op. cit., Vol. 1, p. 88.

5 Cf. O.F.G. Hogg, Artillery: its Origin, Heyday and Decline (London: Hurst & Co., 1970), Ch. 3; L.-N. Bonaparte, op. cit., passim; J.-F. Fino, Forteresses de la France Médiévale (Paris: A. & J. Picard, 1970), pp. 276-92; Charles Foulkes, The Gun-founders of England (Cambridge: 1937), Intro.; Harold Peterson, The Treasury of the Gun (New York: Golden Press, 1962), Chaps. 1, 2.

6 O.F.G. Hogg, op. cit., p. 34.

7 B.H. St. J. O'Neil, Castles and Cannon: A Study of Early Artillery Fortifications in England (Oxford: Clarendon Press, 1960), Chap. I.

8 L.-N. Bonaparte, op. cit., Vol. 2, pp. 97-100.

9 B.H. St. J. O'Neil, op. cit., Intro., p. XV.

10 O.F.G. Hogg, op. cit., p. 34.

11 Brittany, quiescent towards the end of Louis XI's reign, joined an alliance against France but was subdued by a French army using artillery to take the region's strongholds. The marriage of Charles to Anne of Brittany in 1491 marked the annexation and effective end of independence for that province.

12 J.-F. Fino, op. cit., p. 288.

13 L.-N. Bonaparte, op. cit., Vol. 1, p. 109.

14 J.-F. Fino, op. cit., p. 289.

15 O.F.G. Hogg, op. cit., p. 19.

16 Sidney Toy, A History of Fortifications from 3000 B.C. to A.D. 1700 (London: Heinemann, 1955), p. 254.

17 O.F.G. Hogg, op. cit., Chap. 6.

18 Harold Peterson, op. cit., p. 21.

19 Richard A. Preston, Herman O. Werner and Sydney F. Wise, Men in Arms: A History of Warfare and its Interrelationships with Western Society (London: Thames and Hudson, 1962), p. 84.

20 O.F.G. Hogg, op. cit., p. 25.

21 J.F.C. Fuller, A Military History of the Western World (New York: Funk and Wagnalls, 1954) Vol. 1, p. 495.

22 Ibid., p. 496.

23 Richard A. Preston et al., op. cit., pp. 90-91.

24 J.-F. Fino, op. cit., pp. 290-91, Figs. 67, 71.

25 Harold L. Peterson, op. cit., p. 44.

26 O.L. Spaulding et al., op. cit., Pt. 3, Chap. 1, passim, for an account of the Italian Wars.

27 Field Marshal Montgomery, A History of Warfare (London: Collins, 1968), pp. 216-20.

28 O.L. Spaulding et al., op. cit., Pt. 3, Chap. 1.

29 Harold L. Peterson, op. cit., pp. 46-47.

30 Ibid.

Medieval Fortifications

1 Sir Charles Oman, A History of the Art of War in the Middle Ages (New York: Burt Franklin, 1924), p. 542.

2 Cf. J.-F. Fino, op. cit.; Charles Oman, op. cit.; Col. Pierre Rocolle, 2000 ans de fortification française (Paris: Charles-Lavauzelle, 1973); Sidney Toy, op. cit.

3 The French term, literally an encircling, a girding about, will be used henceforth as it is well established in fortifications terminology.

4 Cf. the Welsh Edwardian castles of Beaumaris, and Harlech, also the slightly earlier Caerphilly Castle, as described in Sidney Toy, op. cit., pp. 164-72.

5 J.-F. Fino, op. cit., pp. 311, 430.

6 Cf. Pierre Rocolle, op. cit., p. 130.

7 J.-F. Fino, op. cit., pp. 311, 353, 416.

8 Ibid., p. 390.

9 Such galleries are often referred to by English writers as "brattices" (cf. Toy, p. 197; Oman, p. 534). French authorities distinguish between hourdes, a continuous gallery running the length of a wall, and bretèches, a short gallery covering a limited sector of wall, such as over a gateway.

10 Sidney Toy, op. cit., p. 120.

11 The use of the term "field of fire" refers to the zone of ground covered by missile-projecting weapons of any sort, and does not imply "fire-power" in the literal sense as provided by firearms. Unfortunately, there is no other equivalent term which is satisfactory.

12 Cf. E. Viollet-le-Duc, Military Architecture of the Middle Ages (Oxford: James Parker & Co., 1907), pp. 62-69.

13 The above summary of siege equipment and tactics is based on E. Viollet-le-Duc, op. cit., p. 60-68.

14 Cf. Sidney Toy, op. cit., pp. 161-63, on the sieges of Château Gaillard and Rochester Castle.

15 J.-F. Fino, op. cit., p. 142.

16 Ibid., p. 70.

Gun Towers: Precursors of Angle Bastions

1 B.H. St. J. O'Neil, op. cit., Chap. 1.

2 Cf. E. Viollet-le-Duc, op. cit., pp. 177-82;

Pierre Rocolle, op. cit., Vol. 2, p. 72, Fig. 81.

3 B.H. St. J. O'Neil, op. cit., pp. 4, 24-26.

4 Cf. J.-F. Fino, op. cit., pp. 389-90, 413-15.

5 Ibid., pp. 396-98; Pierre Rocolle, op. cit., Vol. 1, p. 167.

6 J.-F. Fino, op. cit., pp. 421-23; Pierre Rocolle, op. cit., Vol. 1, p. 167, Vol. 2, Fig. 99.

7 Pierre Rocolle, op. cit., pp. 167-68. Although this castle was destroyed during the first World War, a scale model may be seen in the Salle des Plans-reliefs, Musée des Invalides, Paris.

8 J.-F. Fino, op. cit., pp. 358-63.

9 E. Viollet-le-Duc, op. cit., pp. 182-87.

10 J.R. Hale, op. cit., chap. 16.

11 By Francisco de Ollanda, reproduced in J.-F. Fino, op. cit., p. 426.

12 Bertrand Gille, The Renaissance Engineers (London: Lund, Humphries, 1966), p. 213. The first use of explosive mines, generally accredited to Pedro de Navarro at the siege of Naples, was in the same year -- 1503.

13 Atlas de Perpignan avec un plan du Château de Salses et un mémoire sur cette place, Direction des Places du Roussillon et du Languedoc, Perpignan, 1788 (on file, BG).

14 J.-F. Fino, op. cit., p. 420; cf. also Sidney Toy, op. cit., illus. p. 104b, p. 107.

15 J.F.C. Fuller, op cit., Vol. 1, Chap. 17, "The Raising of the Siege of Orleans."

16 Cf. E. Viollet-le-Duc, op. cit., pp. 177-81; J.-F. Fino, op. cit., pp. 327-30.

17 E. Viollet-le-Duc, op. cit., pp. 199-202.

18 Cf. J.-F.C. Fuller, op. cit., Vol. 1, Chap. 18, "The Siege and Fall of Constantinople, 1653."

19 These works were known in French as "moineaux" and in Italian as "capannati" or alternatively "casa matta." The last term survived in both French and English fortification terminology as "casemate" although this usually refers to a chamber in the body of the rampart and not a detached work.

20 Cf. B.H. St. J. O'Neil, "Rhodes and the Origin of the Bastion," Antiquaries Journal, Vol. 34 (1955), pp. 41-54.

Early Bastioned Systems: Italy and the Netherlands

1 Paul M. Kendall, Louis XI (London: Unwin, 1971), p. 175.

2 Kendall-Fry: personal communication.

3 J.R. Hale, op. cit., Pl. 7, 8, 9.

4 Cf. Bertrand Gille, op. cit., plan on p. 119.

5 Cf. J.R. Hale, op. cit., Pl. 31.

6 J.R. Hale, op. cit., pp. 489-90.

7 See note 20, "Gun Towers: Precursors of Angle Bastions."

8 Cf. J.R. Hale, op. cit., p. 490; Pierre Rocolle, op. cit., Vol. 1, p. 181, attributes this work to Ronzani Luciolli.

9 Bertrand Gille, op. cit., p. 134.

10 Pierre Rocolle, op. cit., Vol. 1, p. 186.

11 E. Viollet-le-Duc, op. cit., p. 137, illustrations of the "Boulevard de la porte St. Jacques," p. 132.

12 Pierre Rocolle, op. cit., Vol. 1, pp. 188-89, plans in Vol. 2, Fig. 116. Cf. also Bertrand Gille, op. cit., p. 213, with plans of the enceintes of La Fère (1540) and St. Dizier (1544). The latter is also attributed to the engineer Marini.

13 The term itself -- "bastion" in English and French, bastions in Italian -- has romantic origins, (cf, bastire, to build, in later Latin, OED) in common with bastide, bastille and bastillon. While "bastion" was eventually accepted, the term boulevard, which in the 15th century usually referred to a circular earthwork in front of the main enceinte, was employed for the 16th century and even part of the 17th century as a synonym, along with its variants: bollwork, in German, bulwark in English and baluardo in Italian. The Germanic derivation according to the OED is either a work made of tree-trunks (bole) or a work for throwing (boln).

14 Pierre Rocolle, op. cit., Vol. 1, p. 183. Turin was at this time under French control, but the engineer was Italian.

15 E. Viollet-le-Duc, op. cit., pp. 235-36, Figs. 130, 131. He cites examples at Narbonne, Rouen and Caen, but gives no dates or further details.

16 Girolama Maggi and Iacomo Castriotto, Della fortificazione delle città (Venice, 1564).

17 Barado, Museo Militar (Barcelona, 1886), Vol. 2, p. 31, plan p. 269.

18 Cf. Maggi and Castriotto, op. cit., Book 2, p. 43.

19 Pierre Rocolle, op. cit., Vol. 1, p. 190, plan in Vol. 2, Fig. 116 bis.

20 Hieronimo Cateano, Dell' Arte Militare (Brescia, 1608), Books 1 & 2.

21 Pierre Rocolle, op. cit., Vol. 1, p. 190.

22 Sometimes referred to as the "salient angle," the term "flanked angle" is used exclusively in this text to refer to the point of the bastion (l'angle flanqué) since it appears to be the more correct. This angle is flanked by fire from its neighbouring bastions, whereas a salient angle may be any section of the ramparts protruding towards the country.

23 This concept appears to have led to some confusion for at least one author, cf. Reginald Blomfield, op. cit., p. 33.

24 A. von Zastrow, Histoire de la fortification permanente (Paris: Librarie Militaire, 1866), p. 46.

25 Barado, op. cit., Vol. 2, p. 88.

26 Cf. Reginald Blomfield, op. cit., p. 25.

27 A brief description is given in John Bradford, Ancient Landscapes (London: Bell & Sons, 1957), pp. 270-72, together with an excellent aerial photograph, Pl. 68.

28 A. von Zastrow, op. cit., p. 49.

29 Ibid., p. 50.

30 H. Cateano, op. cit., Books 1 & 2.

31 A. von Zastrow, op. cit., p. 48.

32 Allain Manesson Mallet, Les travaux de Mars (Paris, 1685), Vol. 1, p. 140.

33 Cf. Antoine de Ville, Les fortifications.... (Lyon, 1628), who draws upon recent Dutch examples throughout his text to justify his recommendations.

34 A. von Zastrow, op. cit., p. 51.

35 Ibid., p. 75.

36 Daniel Speckle, Architectura Von Vestungen (Skasburg, 1589).

37 Some confusion has existed in the applica-

tion of these two terms because the meanings changed slightly over the course of generations and because by the 18th century the French retained the term "*demi-lune*" for the work in front of the curtain in preference to "ravelin," which was used elsewhere, particularly in English. As used by the Dutch, the *demi-lune* was a work placed in front of bastion, whereas the ravelin was placed before the curtain. This distinction is clearly made by the Dutch writer Adam Freitag, whose work on fortifications was published in 1630; cf. also Manesson Mallet, op. cit., Vol. 1, pp. 56-58.

38 A. von Zastrow, op. cit., pp. 50, 75, notes that Alghisti da Carpi in treatises published in Venice in 1570 and 1584, proposed a form of tenaille, while more complex outworks were suggested by Francesco da Marchi, who had worked in the Low Countries.

39 Cf. Blaise François, Comte de Pagan, *Les Fortifications*, Chap. 10, who describes a tenaille as simply a front of fortification formed by the faces and flanks of the bastions each side of a curtain. The work frequently appearing in Vauban's fortifications, also called "tenaille," was of different design, and will be discussed later.

40 Cf. Jean Errard de Bar-le-Duc, *La fortification démonstrée et reduicte en art* (Paris, 1620), pp. 115, 118, 119.

41 Cf. A. Manesson Mallet, op. cit., Vol. 1, pp. 56-60.

42 Cf. Antoine de Ville, op. cit., p. 141. Also cf. Robert Ward, *Animadversions of Warre* (London, 1639), p. 93, who notes that the Dutch built five great horn-works around Breda prior to Spinola's great siege, one of which is illustrated.

43 Reginald Blomfield, op. cit. p. 49.

44 The foremost Dutch writers were Adam Freitag, *L'architecture militaire* (1635) and Samuel Marolais, whose work was first published in Amsterdam in 1615, with an English edition in 1638, as cited in Blomfield, op. cit., p. 25.

45 Antoine de Ville, op. cit., who frequently refers to these fortresses to demonstrate a point.

46 Henry Hexham, intro. to English translation of *The Art of Fortification or Art militaire as well as Offensive as Defensive*.... as cited in Blomfield, op. cit., p. 25.

47 Baron Menno Von Coehoorn, *The New Method of Fortification* (London: Midwinter, 1705).

The First French Military Engineers

1 Countess Morphy, *Recipes of All Nations* (London: Hubert Joseph, n.d.), p. 122.

2 A. Allent, *Histoire du Corps Impérial du Génie* (Paris: Magimel, [1805]), pp. 14-15.

3 Ibid., pp 18-25.

4 J. Errard de Bar-le-Duc, op. cit.

5 A. Allent, op. cit., p. 22.

6 Pierre Rocolle, op. cit., Vol. 1, p. 208.

7 Ibid.

8 J. Errard de Bar-le-Duc, *La géométrie et practicque générale d'icelle* (Paris, 1594).

9 J. Errard de Bar-le-Duc, *La fortification demonstrée*, p. 39.

10 Cf. Reginald Blomfield, op. cit., p. 31; A. von Zastrow, op. cit., p. 197.

11 J. Errard de Bar-le-Duc, *La fortification demonstrée*, p. 38.

12 Ibid.

13 The French term, *tracé*, is also used in English fortification terminology to refer to the ground-plan of a defensive work.

14 "Rampart" refers to the defensive unit comprising the masonry retaining wall or escarp in front and the mass of earth fill behind, and derives from the 15th-century practice of reinforcing the medieval curtain-wall with earth (*rampirer*, *rempirer*) to better resist artillery. Cf. E. Viollet-le-Duc, *Military Architecture*, p. 215; also OED, "rampire." The defensive strength of a fortification thus lies in the ability of the entire mass to withstand shock, and not on the visible masonry component. The Dutch relied to a great extent on demi-revetted ramparts or ones built entirely of earth, while small temporary works in the 17th and 18th centuries usually had ramparts of earth alone. With the increase in the power of artillery in the 19th century, masonry components of ramparts constituted more of a danger to defenders than a protection and were gradually abandoned.

15 Cylindrical wicker baskets filled with earth; used as makeshift protection both in attack and defense.

16 J. Errard, *La fortification demonstrée*, p. 44.

17 Trincano, *Elémens de fortification, de l'attaque et de la défense des places* (Paris, 1768).

18 J. Errard, *La fortification demonstrée*, p. 1.

19 According to A. Allent, op. cit., p. 25, Chastillon was the first director of fortifications appointed to the district of Champagne, Brie et les Trois Evêchés.

20 Claude Chatillon, *Topographie françoise ou représentations de plusieurs villes, bourgs, chasteaux, places, forteresses, vestiges d'antiquité, maisons modernes et autres du Royaume de France. La plupart sur les desseings de deffunct Claude Chatillon, Ingénieur du Roy* (Paris, 1655.)

21 Samuel Marolais, *Fortifications ou architecture militaire* (The Hague, 1615).

22 Sieur de Fabre, *Les practiques sur l'ordre et regle de fortifier, garder, attaquer, et deffendre les places* (Paris, 1629).

23 A. Allent, op. cit., pp. 27-38.

24 Antoine de Ville, op. cit.

25 Ibid., pp. 7-8.

26 Col. P. Lazard, *Vauban, 1633-1707* (Paris: Alcan, 1934), p. 17.

27 A. von Zastrow, op. cit., p. 199.

28 BG, Picardy, 1640-50, *Atlas 100*, plan No. 44.

29 Antoine de Ville, op. cit., p. 141.

30 BG, *Recueil des Places Fortes*, 1604-40, plan No. 51.

31 Antoine de Ville, op cit., p. 108.

32 Cf. P. Lazard, op. cit., p. 465.

33 Antoine de Ville, op. cit., p. 349.

34 Ibid.

35 Ibid., p. 352.

36 Ibid., p. 278.

37 Ibid., p. 273.

38 A small cannon firing a ball weighing 14 oz. Cf. L.-N. Bonaparte, op. cit., Vol. 1, p. 163.

39 The use of explosives in mining had been known since the beginning of the 16th century: an illustration in the treatise of Francesco di Giorgio Martini, the Italian architect and engineer, shows a powder-mine beneath a medieval castle. Cf. Bertrand Gilles, op. cit., p. 107. Pedro Navarro is generally credited with having introduced the technique into siege warfare during the Spanish campaigns in Italy 1500-03, and little improvement was made on his methods thereafter. Ibid., p. 131. For a good general description on mining, *see* Christopher Duffy, op. cit., pp. 136-43.

40 A. Allent, op. cit., p. 30.

41 P. Lazard, op. cit., p. 16.

42 A. von Zastrow, op. cit.

43 A. Allent, op. cit., p. 33.

44 Blaise François, Comte de Pagan, op. cit.

45 A. von Zastrow, op. cit., p. 110.

46 Cf. Pierre Recolle, op. cit., Vol. 1, p. 211, n. 152.

47 Blaise François, Comte de Pagan, op. cit., p. 2.

48 Ibid., p. 9.

49 Ibid., p. 5.

50 *Contre-garde* in French. The term *couvre-face* (face-cover) appears to have been an alternative usage with no difference in meaning.

51 Cf. John Muller, *A Treatise Containing the Elementary Part of Fortification, Regular and Irregular* (Ottawa, 1968), pp. 131-38.

52 Cf. Reginald Blomfield, op. cit., p. 38; Pagan designed defences for modernizing the medieval citadel of Blaye in 1652, but the work was carried out by Vauban.

53 Trincano, op. cit., p. 71.

Perfection of the Art: Vauban

1 Winston S. Churchill, *Marlborough: His Life and Times* (London: Harrap & Co., 1947), Book I, p. 632.

2 Menno von Coehoorn, *The New Method of Fortification* (London: Midwinter, 1705).

3 John Muller, op. cit., p. 88.

4 P. Lazard, op. cit., p. 373, citing phrases attributed to Vauban by his secretary, Thomassin, in his "Mémoires."

5 Sebastien Le Prestre de Vauban, *Traité de l'attaque et de la défense des places* (The Hague, 1737); *Mémoire pour servir d'instruction dans la conduite des sièges et dans la défense des places* (Leyden, 1740), translated with introductory text by George A. Rothrock as *A Manual of Siegecraft and Fortification* (Ann Arbor: University of Michigan Press, 1968).

6 Cf. Reginald Blomfield, op. cit., pp. 205-6, for a partial list; A. Allent, op. cit., p. 524, credits him with building 30 new places and an unspecified number of improved frontier places; C.F. Mandar, *De l'architecture des forteresses* (Paris: Librairie pour l'Art militaire, 1801), p. 225, notes that an inventory by Vauban in 1705 listed 119 fortified towns, 34 citadels, 58 forts or châteaux and 86 lesser works (total: 297). This was presumably the basis for the figure of 300 given by de Fontenalle, cited in David Chandler, *The Art of Warfare in the Age of Marlborough* (London: Batsford, 1976), p. 273.

7 The most useful sources are the biographies written by P. Lazard in 1934 and by Reginald Blomfield in 1938.

8 Reginald Blomfield, op. cit., p. 6.

9 Cf. George A. Rothrock, op. cit., Preface, p. viii.

10 C.F. Mandar, op. cit., p. 541.

11 Cited in Pierre Rocolle, op. cit., Vol. 1, p. 236.

12 e.g. the plans made by de Clerville, Vauban's predecessor and erstwhile superior: BG, *Recueil des Plans -- Picardy, Artois, Hainault, Flandres*, Atlas 102.

13 Cf. Reginald Blomfield, op. cit., pp. 39-41.

14 George de Fournier, *Traité des fortifications ou architecture militaire* (Paris, 1648), cited in Reginald Blomfield, p. 40.

15 George de Fournier, op. cit., p. 56.

16 Cf. Claude François Milleit, *L'art de fortifier, de defendre et d'attaquer Les places* (Paris, 1684).

17 Reginald Blomfield, op. cit., pp. 9-10.

18 Pierre Rocolle, op. cit., Vol. 1, p. 223.

19 John Muller, op. cit., p. 35. Muller illustrates three variants of the tenaille: Figs. 1-3, Pl. 2.

20 P. Lazard, op. cit. pp. 377-78.

21 For a general plan of the citadel, *see* Pierre Rocolle, op. cit., Vol. 2, Figs. 142, 144.

22 Cf. A. de Ville, op. cit., p. 5; B.F. Pagan, op. cit., Chap. 3.

23 A. de Ville, op. cit., p. 139.

24 B.F. Pagan, op. cit., Chap. 12.

25 A copy of a plan of Ath, dated 1702, is given in Blomfield opposite p. 138. The smallness of the scale (and perhaps the inaccuracy of the engraver) give the impression that the flanks are at right angles to the curtain, but the model in the Salle des Plans-reliefs, Musée des Invalides, Paris, shows that this is not so. The model of Ath, made in 1668, was the first of 50 such models of fortresses.

26 Allain Manesson Mallet, op. cit., Vol. 2, p. 41.

27 Ibid.

28 A. Allent, op. cit., p. 76.

29 John Muller, op. cit., Preface, p. VIII, also p. 46.

30 Cf. Ian V. Hogg, *Forteresses* (Paris: Vilo, 1976), pp. 42-43 -- an aerial view of Naarden, p. 67, Fig. 21, illustrating Coehoorn's second system.

31 Cf. John Muller, op. cit., p. 30, also his criticisms of Belidor's & Blondel's proposed systems, pp. 116-31; Trincano, op. cit., p. 29.

32 P. Lazard, op. cit., pp. 371-93.

33 A text published in 1689 by de Cambray, cited in Blomfield, op. cit., p. 163.

34 The Corp of Engineers received its official military status in the royal decree dated 7 February 1744; prior to this, following Louvois' death in 1691, Louis XIV had created a "Département des fortifications des places de terre et de mer" by merging the engineering services of the ministries of War and Marine into a new ministry under Le Pelletier seconded by Vauban. Until 1744 the corps was separate from the army, and the authority and responsibilities of the engineers only

vaguely defined. For details of the evolution of the "Corps Royal du Génie," see Anne Blanchard, Les Ingénieurs du "Roy" de Louis XIV à Louis XVI (Montpellier: Université Paul-Valéry, 1979), pp. 71-81, 115-17, 152-63, 181-225. (This work is concerned principally with the social origins of the engineers; a second volume concerning their training and achievements is in preparation.)

35 De Fer, Force de l'Europe: Introduction à la fortification (Paris, 1695), p. 127.

36 "toute cette frontière [Savoy] est si extraordinairement bossillée, qu'il m'a fallu inventer un nouveau système de fortification pour en tirer parti." Cited in Blomfield, op. cit., p. 128.

37 "Comme les situations de ces trois places [Colmars, Entrevaux et Guillaumes] sont toutes bossillées et également commandées, de près et de loin, des hauteurs qui les environnent, il n'y a qu'une méthode de fortification à y observer qui est celle des tours bastionnées...." Cited in Rocolle, op. cit., Vol. 1, p. 225.

38 "... fort serrée et environnée de très grandes montagnes, à demi escarpées, qui la pressent de si près, que de la plus éloignée on y pourrait jeter des pierres avec une fronde ... de logement à Miquelets, d'où l'on peut canarder à coups de fusils tout ce qui paraîtrait dans les rues...." Anny de Pous, La Cité du Marbre: Villefranche (Paris: Éditions du Cadran, 1971), p. 12.

39 The model of Villefranche to be seen in the Salle des Plans-reliefs, Musée des Invalides, Paris, shows the defences essentially as they were in Vauban's time.

40 Pierre Rocolle, op. cit., Vol. 1, p. 225.

41 John Muller, op. cit., p. 86.

42 Général J.-J. Pelet, Mémoires militaires relatifs à la succession d'Espagne sous Louis XIV (Paris, 1861), Atlas, plan No. 10.

43 A description of Neuf Brisach is given in Reginald Blomfield, op. cit., pp. 51-54, with plans and sections reproduced from Belidor's text.

44 P. Lazard, op. cit., pp. 379-81.

45 Ibid., p. 380.

46 B.F. Pagan, op. cit., p. 9.

47 Cf. George A. Rothrock, op. cit., Intro.

48 A. Allent, op. cit., p. 107.

49 Reginald Blomfield, op. cit., p. 110.

50 Sebastien Le Prestre, Maréchal de Vauban, Traité de l'attaque et de la défense des places (The Hague, 1737); Mémoire pour servir d'instruction dans la conduite des sièges et dans la défense des places (Leyden, 1740).

51 P. Lazard, op. cit., p. 465.

52 Cf. P. Lazard, op. cit., pp. 449, 451, 466.

53 Reginald Blomfield, op. cit., p. 159.

54 For a detailed description of the artillery of the period, see David Chandler, op. cit., Pt. 3: The Artillery Trains, passim.

55 P. Lazard, op. cit., p. 470.

56 Christopher Duffy, op. cit., p. 130.

57 David Chandler, op. cit., p. 65.

58 Ibid., p. 280; cf. also Christopher Duffy, op. cit., pp. 167-84.

59 Cf. Philippe Erlanger, Louis XIV (London: Corgi, 1972), p. 189.

60 P. Lazard, op. cit., p. 452.

61 AG, CTG, Article 21, Sect. 1, 1, Carton 1. e.g. Item 12, Système proposé par Gittard, 1709; Item 20, Réflections sur les flancs des Bastions de Chermont, 1715; Commentaires de Valory, 1715.

62 Belidor, La science des ingenieurs dans la conduite des travaux de fortification et d'architecture civile (Paris: Jombert, 1729).

63 Cf. Winston Churchill, op. cit., Book 2, pp. 872, 962.

64 Vauban to Louvois 1673, cited by, among others, Blomfield, op. cit., p. 74.

65 Cf. Pierre Goubert, Louis XIV and Twenty Million Frenchmen, (New York: Random House, 1970), pp. 290-301.

66 It was in fact common practice for engineers to compile personal dossiers of their own plans, maps and working drawings along with written comments on the theory and practice of defence; this could be used as a means of instruction for junior officers. These dossiers are deposited in the Bibliothèque du Génie. One of the most useful and comprehensive is that of Claude Masse (BG, Ms 131d [in folio]), prepared for the benefit of his son. It could serve as a manual of fortification in its own right.

67 Louis Cormontaigne, Des oeuvres postumes, Vol. 1, Mémorial pour la fortification permanente et passagère; Vol. 2, Mémorial pour l'attaque des places; Vol. 3, Mémorial pour la défense des places (Paris: Barrois, 1806-09). Second edition edited by Lt. Col. Augoyat (Paris: Anselin et Pochard, 1824), Vol. 1, pp. 75-77; 129-31. See also C.F. Mandar, op. cit., pp. 583-86.

68 René-Marc, Marquis de Montalembert, La fortification perpendiculaire ou essai sur plusieurs manières de fortifier la ligne droite, le triangle, le carré et tous les polygones (Paris: Denis, 1776-96). Although Montalembert's theories eventually gave rise to the Austrian and Prussian polygonal or perpendicular systems which superseded the bastioned system in the 19th century, over the course of some 20 years and 11 volumes the author cast about for a solution to the age-old problem of gaining ascendancy of the defence over the attack, and several different systems, some quite conventional, were proposed. Interestingly enough, his main concern -- to provide efficient flanking fire without exposing the artillery -- and his solution -- well-protected casemate fire -- are not incompatible with Vauban's tours bastionnées.

69 e.g. Thomas Kimber, The Construction of Vauban's First System (London: Parker, Furnival & Parker, 1851); Isaac Landmann, Principles of Fortification, reduced into questions and answers for the use of the Royal Military Academy at Woolwich (N.p., 1851); Major G. Philips, R.E., Elementary Course of Field and Permanent Fortifications (London: Pardon and Sons, 1874).

70 For details of fortress construction, see Christopher Duffy, op. cit. See also Belidor, op. cit.

Louisbourg: A Historical Introduction

1 Cf. Pierre Goubert, op. cit., pp. 264-65.

2 J.S. McLennan, Louisbourg from its Foun-

dation to its Fall (Sydney: Fortress Press, 1969), p. 12.

3 J.S. McLennan, op. cit., Chaps. 2 & 3, passim.

4 Directly as a result of the massive reconstruction project now reaching its final phases, much pertinent material has been acquired and much has been written although relatively little has been published to date. For an overall appreciation, J.S. McLennan, op. cit., thus remains an authoritative source. More recently, an assessment of French construction in the area has furnished a useful outline of pertinent events at Louisbourg among other places: F.J. Thorpe, "The Politics of French Public Construction in the Islands of the Gulf of St. Lawrence, 1695-1758," Ph.D. thesis, University of Ottawa, 1973. The historical summary is based on this work unless explicit reference to the contrary is made.

5 For a detailed examination of the economics of trade and its significance for the colony, *see* Christopher Moore, "Merchant Trade in Louisbourg, Isle Royale," MA thesis, University of Ottawa, 1977.

6 The incidents leading up to the first siege of Louisbourg and an account of the siege itself are described in J.S. McLennan, op. cit., Chaps. 8-10, passim.

7 Ibid., p. 134.

8 G.A. Rawlyk, *Yankees at Louisbourg* (Orono, Maine: University of Maine Press, 1967), pp. 152, 157.

9 For background to the acts of hostility on both sides, *see* J.S. McLennan, op. cit., Chap. 11 passim.

10 The expedition led by the Duc d'Anville, broken by Atlantic storms off the Nova Scotia Coast. *See* ibid., p. 174; also G.A. Rawlyk, op. cit., pp. 157-58.

11 McLennan cites documentary evidence from the "Journal du siege de Louisbourg, 1758" to the effect that Franquet was seriously ill all this time, which would have reduced his effectiveness when considerable energy was required: J.S. McLennan, op. cit., p. 198.

12 Again, McLennan's account is valuable in its detail: ibid., Chaps. 13, 14, passim.

13 Part of Pitt's instructions to Amherst, February 1760, cited in ibid., p. 290.

14 For a discussion on the concepts of restoration vs. reconstruction, *see* Bruce W. Fry, "Restoration and Archaeology," *Historical Archaeology*, Vol. 3 (1969), pp. 49-65.

Louisbourg: The Setting

1 AN, Col. B, 35, ff. 248-v-251-v, cited in J.S. McLennan, op. cit., p. 10; also F.J. Thorpe, op. cit., p. 22.

2 "On y [at Louisbourg] auroit fait le principal Etablissement si ce port avoit pu estre aisement fortifiée, et s'il y avoit eu assés de grave pour y faire secher le poisson des Vaisseaux de pescheurs, mais le peu de grave qu'il y a et la depense immense qu'il en auroit couté pour mettre ce port entièrement hors d'insulte determina le feu Roy sur la demande des officiers de l'Isle Royalle et des Negocians du Royaume a faire partir le principal Etablissement au Port Dauphin ... Le Conseil fera observer au Sr. de Verville au sujet de ses fortifications qu'il ne convient point par raport aux grandes depenses que cela cause, de fortifier aussi en grand dans les colonies que l'on fait en Europe...." AN, Col. F^3, Vol. 51, pp. 2-9, Instructions to Verville from the Council of Marine, 23 June 1716.

3 "Elle [sa Majesté] s'est déterminée a commencer les fortifications de cette Isle par le Port de Louisbourg comme le Port le plus important tant par raport aux avantages qu'il a sur les autres pour la pesche par sa situation." AN, Marine A^1 54, p. 61, Mémoire du Roy au Sieur de Costebelle et au Sieur Soubras, 26 Juin 1717.

4 As suggested in F.J. Thorpe, op. cit., p. 28.

5 "Suivant le sentiment de tous les marchands et pescheurs paroist a ce sujet le meilleur de l'Isle." AN, Col. F^3, Vol. 51, p. 23.

6 "Par l'heureuse disposition du Terrain pour la fortification, par la difficulté de l'Entrée du port en ôtant les balises, par la bonté du terrain et par la proximité de l'Acadie avex les avantages de la pesche, ce port est un des meilleurs postes de l'isle." Ibid., p. 27.

7 Ibid., pp. 74, 54, 85, 93-94. A summary of comparative costs is given by Verville as follows: Louisbourg: 121 244 l.; Port Dauphin 85 468 l.; Port Toulouse 106 783 l., and defensive works at Baye Royalle, 16 082 l.

8 Ibid., pp. 95-96, "Mémoires du Conseil de marine au Sieur de Verville, Brigadier d'Ingenieurs."

9 "On avoit assuré que la plage de Louisbourg ne pouvoit estre abordée en aucune Saison et qu'il seroit inutile de la fortiffier.... On a debarqué a cinq endroits dans une seule matinée, il est bon d'examiner de pres ce que l'on dit en Amerique." Ibid., p. 172.

10 F.J. Thorpe, op. cit., p. 36.

11 Cf. AN, Col. F^3, 51, pp. 193-94, instruction to Verville, 10 June 1718 (also cited in F.J. Thorpe, op. cit., p. 33).

12 "C'est une place en amphitheatre commandée par diverses hauteurs de façon que le Boulet & la bale l'enfilent au point, que l'on n'y peut estre en sureté nulle part, ny dans les maisons ny dans les rues." AN, Col. $C^{11}B$, Vol. 29, fol. 366, "Mémoire sur l'Isle Royale" par M. Roma, officier, 1750. Roma was not, in fact, a military man, but had authorization to found a fisheries venture on Ile St. Jean (Prince Edward Island).

13 Recent studies have shown that the sea level is rising at a rapid rate. Along the Cape Breton coastline it is approximately 80 cm (2.63 ft.) higher than during the French régime (D.R. Grant, "Recent Coastal Submergence of the Maritime Provinces," *Canadian Journal of Earth Science*, Vol. 11 (1970), pp. 70-79).

14 Precise figures on the range of muzzle-loading cannon in the 18th century cannot be given with any accuracy as too many variables existed; however, at the time of the first siege of Louisbourg one authority records point-blank range "of different pieces of cannon" as "about 300 fathom," while extreme range of "random shot" varies between 2250 fathoms for a 24-pounder to 1520 for a 4-pounder.

Based on an English fathom, an average point-blank would be 1800 ft. or 548.64 m; based on the French *toise*, we would have 1918.8 ft. or 584.85 m. "Point-blank" range is obtained by firing the gun with the barrel horizontal. "Random shot" with the barrel elevated to 45 degrees would vary between over 4000 m and 2900 m.

Guillaume Leblond, *A Treatise of Artillery* (Ottawa: Museum Restoration Service, 1970), p. 42.

15 "Le terrain qui est en avant, est un composé de roc, et d'une nature a former de difficultés quasi insurmontables au cheminement d'une tranchée, d'ou je conclus qu'au moyen des augmentations projettées [raising the glacis, placing more traverses on the covered way, and enlarging the place d'armes] l'on n'approchera des dits trois fronts [those facing landward] que difficilement, et avec les formalités d'un siege en regle." BG, Ms 205b, A Mgr. Rouillé Ministre et Secrétaire d'état de la marine, Louisbourg, 13 Oct. 1750, p. 12.

16 "Veue du Port de Louisbourg dans l'Isle Royalle," (Dépot des Cartes et Plans de la Marine, Service Hydrographique, Portefeuille 131, printed in 1716 or 1717, artist unknown), published in John Fortier, comp., "The Fortress of Louisbourg: Cartographic Evidence," APT, Vol. 4, Nos. 1-2 (1972), Fig. 1.

17 Canada. Department of Mines and Technical Surveys. Geological Survey of Canada. Geological Series, Maps 1056A, Sheet 11 G/13 (Louisbourg).

18 Information concerning soil formation and local soil types has been provided by the Nova Scotia Soil Survey Station of the Government of Canada Department of Agriculture Research Branch, Truro, Nova Scotia. The author is particularly indebted to James I. McDougall, and to pedologist John L. Nowland, who worked closely with Louisbourg staff for several years, examined archaeological sections, prepared soil profiles and gave many invaluable lectures on the subject.

19 For a more complete description of typical soil horizons, *see* National Soil Survey Committee of Canada, *Proceedings of the Sixth Meeting of the National Soil Survey Committee of Canada*, 18-22 Oct. 1965, Laval University, Quebec.

20 Cf. Iain C. Walker, "Preliminary Report: Excavations at King's Bastion, Fortress of Louisbourg, September to December 1962," manuscript on file, FLNHP, p. 28; Peter D. Harrison, "Report on the Right Face Casemates, King's Bastion, Fortress of Louisbourg," manuscript on file, FLNHP, Fig. 17.

21 Pollen analysis supplied by the Pleistocene Palynology Laboratory, Geological Survey of Canada, Department of Mines and Technical Surveys.

22 Cf. F.J. Thorpe, op cit., p. 292.

23 Based on identification of 50 wood samples located in the King's Bastion. Analysis supplied by the Department of Forestry, Forest Products Research Branch, Ottawa Laboratory.

24 Identified as purple heath-grass (Molinia caerulea): W.G. Dore and A.E. Roland, "The Grasses of Nova Scotia," *Proceedings of the Nova Scotian Institute of Science*, Vol. 4 (1942), p. 212.

25 Cf. "dent de chien" recommended by de Ville, op. cit., p. 275.

26 Details on the history of the Louisbourg area subsequent to 1760 are based on Wayne Foster, "Post-Occupational History of the Old French Town of Louisbourg 1760-1930," manuscript on file, FLNHP.

27 "Memo re Louisbourg Historic Park" draft prepared for approval of the Historic Sites and Monuments Board of Canada by Judge W. Crowe, 23 March 1929; copies to Major Pinard, Secretary of the Board, and Senator J.S. MacLennan, documents on file, FLNHP.

28 J. Russel Harper, "The Fortress of Louisbourg: A report of preliminary archaeological investigations carried out in the summer of 1959 under contract with Department of Northern Affairs and National Resources," manuscript on file, FLNHP and Historic Sites Service, Ottawa, n.d.

29 Labour and material costs; copies on file, FLNHP.

30 J. Russel Harper, op. cit.

The King's Bastion

1 Minutes of planning committee meeting, 7 May 1962, document on file, FLNHP.

2 R.L. Way, "Report on the defensive works of the King's Bastion, April 30, 1962," document on file, FLNHP.

3 Harper's general conclusions reinforced this point of view, although his investigations of the Citadel were limited to cursory examination of the casemates with no attempt to excavate to undisturbed natural soil. J. Russel Harper, op. cit., sect. M, pp. 297-307.

4 Cf. F.J. Thorpe, op. cit.

5 Memorandum from Project Manager to Director, National Parks Branch, 2 Nov. 1962; memorandum from Deputy Minister to Director, National Parks Branch, 29 Aug. 1962; documents on file, FLNHP.

6 Edward McM. Larrabee, "Archaeological Research at the Fortress of Louisbourg, 1961-65," *Canadian Historic Sites: Occasional Papers in Archaeology and History*, No. 2 (1971), pp. 8-43.

7 James H. Howard, "The Archaeology of the King's Bastion, 1962," manuscript on file, FLNHP.

8 James H. Howard, op. cit., p. 5.

9 The formulators of this research model were F.J. Thorpe, B.C. Bickerton and E. McM. Larrabee, then respectively research director, senior historian and senior archaeologist.

10 For details on contract work and the preparation of cost estimates, *see* F.J. Thorpe, op. cit., Chap. 5.

11 Blaine Adams, "The Construction and Occupation of the Barracks of the King's Bastion at Louisbourg," *Canadian Historic Sites: Occasional Papers in History and Archaeology*, No. 18 (1978), p. 61, p. 137, n2.

12 J.S. McLennan, op. cit., p. 85.

13 AN, Outremer, DFC, IV-247; BN, CP, Ge BB 563 (3).

14 AN, Col. F^3, Vol. 51, p. 95, Conseil de la Marine to Verville, 3 July 1717.

15 Ibid., p. 19, Devis ... concernant les tra-

vaux des fortifications, Verville, Oct. 1716.

16 Ibid., p. 60.

17 e.g. Mannesson Mallet, op. cit., p. 197; BG, Ms 131d (in folio), fol. 1, Claude Masse, "Mémoire," Fig. 1.

18 AN, Col. F^3, Vol. 51, p. 129, instruction to de Couagne, 1717.

19 "... si le terrain est de bonne consistance, & qu'on ne craigne pas les éboulements, on donne aux banquettes OP, qui doivent se trouver derriere le revetement, le plus de hauteur qu'il est possible; & une largeur suffisante seulement pour se soutenir, afin que quand la muraille sera élevée, l'on n'ait que peu de remblais à faire, ce qui diminue la poussée des terres...." Belidor, op. cit., Book 3, p. 47, Pl. 47.

20 AN, Col. F^3, Vol. 51, p. 105.

21 Ibid., pp. 194-226, Devis et conditions ... des ouvrages, 1718.

22 AG, CTG, Article 14, Piece 10, Item 4 (n.p.), "Mémoire du Roy an sujet des fortifications de l'Isle Royalle," 14 July 1719; AN, Col. C^{11}B, Vol. 4, pp. 278-82, "Marché du Sieur Isabeau Entrepreneur pour la construction des fortifications a l'Isle Royalle," 7 March 1719.

23 For details on the contract system and the Louisbourg contractors, *see* F.J. Thorpe, op. cit., Chap. 5. *See also* Belidor, op. cit., Book 6, pp. 1-5.

24 Cf. AG, CTG, Article 3, Sect. 9, Carton 1, Piece 7a, "Mémoire de fonctions d'un ingénieur en chef du Project," 1709; ibid., Pièce 8, "Fonctions de l'Ingénieur en chef d'une place," 1720.

25 AN, Col. C^{11}B, Vol. 9, p. 179, 4 May 1727; pp. 231-49, 15 Nov. 1727; ibid., Vol. 12, pp. 122-47, 1 Sept. 1731.

26 Cf. J.H. Howard, op. cit., p. 9.

27 AN, Col. C^{11}B, Vol. 5, p. 59.

28 RUS, "Plan and Profil [sic] of the Mines for the Demolition of the Fortifications of Louisbourg completed the 8th of November 1760," François de Ruvygnes; British Museum, Add. Mss. 33231, "Plan and Sections of the Galleries and Mines," 1761.

29 AG, CTG, Article 14, Carton 1, Pièce 52, "Mémoire des ouvrages faits dans le courant de cette campagne," Franquet, 1757.

30 AG, CTG, Article 15, Pièce 7 (n.p.), "Mémoire sur Louisbourg," Franquet, 1758.

31 PAC, MG 11, CO 217, Vol. 28, pp. 191-200, Knowles to Secretary of State, 19 July 1746; PRO, CO 5, Vol. 13, pp. 205-7, Plan of Louisbourg copied from the Plan of Capt. Bastide Engineer 1746 (Pettigrew copy).

32 "Le flanc droit du Bastion est une des parties qui a le plus souffert de l'artillerie des assiegants le parrement sur sa longueur est demoly a quatre pieds de profondeur par le haut en venant a rien jusqu'a sa fondation." AN, Col. C^{11}B, Vol. 28, pp. 298-302, "rapport sur les fortiffications," Boucher, 24 July 1749.

33 Ibid.

34 AG, CTG, Article 14, Carton 1, Pièce 45, Rouillé to Franquet, 15 March 1752.

35 Ibid., Franquet to Rouillé, 25 May 1752.

36 AN, Col. C^{11}C, Vol. 16 (n.p.), St. Julhien to minister, 20 Sept. 1757.

37 Belidor, op. cit., Book 3, p. 70.

38 AG, CTG, Article 14, Carton 1, Pièce 13, "Plan des fondations du Grand Bastion de Louisbourg avec une partie des excavations et des rigolle pour l'ecoulement des eaux, faites pendant l'année 1720"; ibid., Pièce 14, "Plan de Louisbourg avec ses augmentations faites pendant l'année 1720" (Boucher); BN, CP, c. 15980, "Plan de ville de Louisbourg avec les fortifications du coste des terres," date unknown (ca. 1718).

39 AN, Col. C^{11}B, Vol. 18, pp. 11-15, St. Ovide de Brouillan to minister, 7 Nov. 1736.

40 Ibid., Vol. 5, pp. 135, St. Ovide & Mézy reporting on progress of the fortifications, June 1720.

41 Ibid., p. 138v.

42 Ibid., Vol. 7, p. 6, the king to St. Ovide & Mézy, 9 May 1724.

43 Ibid., Vol. 11, p. 19, de Bourville & Mézy to minister, 3 Dec. 1730.

44 Ibid., Vol. 13, p. 12, Mézy to minister, 3 Feb. 1732; ibid., Vol. 12, p. 105v, Verrier to minister, 29 Nov. 1731. This letter refers to the revetment of "la face gauche," but this must be assumed to be an error since that wall had already been completed and the right face is the only area to match the description.

45 At the bottom of casemates 3, 4, 5 and 8R.

46 AN, Col. C^{11}B, Vol. 9, p. 143, Verrier to minister, 27 Nov. 1727.

47 Ibid., Vol. 20, p. 223, Verrier to minister, 2 Jan. 1738.

48 Ibid., Vol. 29, pp. 276v, 278, Boucher to minister (Fortifications. Etat des ouvrages....), 20 Nov. 1750.

49 Ibid., Vol. 33, p. 221. The comments are made in the margin of Franquet's report dated 9 October 1753, but the author of the additions is unknown; possibly the *commissaire-ordonnateur*, Prevost.

50 The most common dimensions for floor joists recorded in the *toises* dealing with other structures in Louisbourg were 8 *pouces* by 9 *pouces* by whatever length was required. Assuming a span of 12 *pieds* for the casemate, such joists, centred on the holes observed in the wall, would support a load in excess of 100 lb./ft.^{2}, or 490 kg/m^2.

51 Belidor, op. cit., Book 6, p. 44.

52 Louisbourg Historical Section, Preliminary Architectural Studies, manuscript on file, FLNHP, 1971-72, Vol. 3; A Preliminary Study of Floors.

53 AN, Outremer, G^2, Vol. 180, pp. 558-59.

54 The *mémoires* of Gaspard Chaussegros de Léry (PAC, MG 18, K2) and Claude Masse (BG, Ms 131d [in folio]) were the most useful for this study.

55 PAC, MG 18, K2, Gaspard Chaussegros de Léry, "Traite de fortification."

56 Cf. Trincano, op. cit., p. 45.

57 BG, Ms 131d (in folio), Claude Masse, "Mémoire ou traite fortification: Parapets; Discours des Profiles."

58 Canada. Dept. of the Environment. Parks Canada. Fortress of Louisbourg National Historic Park. Archives. Sébastien le Prestre de Vauban, "Traité de Construction des Places de guerre," Book 1, Chap. 4.

59 Louis Cormontaigne, op. cit.

60 PAC, MG 18, K2, Gaspard Chaussegros de Léry, "Traite de fortification...."

61 Ibid.

62 AN, Col. $C^{11}B$, Vol. 12, p. 105, Verrier to minister, 29 Nov. 1731; AN, Col. B, Vol. 57, p. 752, minister to Verrier, 9 June 1732.

63 AN, Col. $C^{11}B$, Vol. 14, p. 300, Verrier to minister, 23 Oct. 1733.

64 Ibid., Vol. 16, p. 183, Verrier to minister, 6 Nov. 1734.

65 Ibid., Vol. 28, pp. 298-329v, Boucher to minister, 30 Aug. 1749.

66 AG, CTG, Article 14-1, Pièce 33, 24 Nov. 1751; AN, Col. $C^{11}B$, Vol. 31; AN, Col. $C^{11}A$, Vol. 126.

67 "Les 7 embrazures a Retablir sur le flanc droit du Bastion du Roy comme elles estoient cy devant." AN, Col. $C^{11}B$, Vol. 28.

68 Ibid., Vol. 31, f. 165v, Franquet to minister, 15 Dec. 1751.

69 AN, Outremer, DFC, 204 (n.p.), Etat de la depense extraordinaire, Verrier to minister, 30 Oct. 1744.

70 AN, Col. $C^{11}B$, Vol. 11, p. 76v, Verrier to minister, 10 July 1731; ibid., Vol. 31, p. 144, Franquet's mémoire, 15 Dec. 1751; PAC, MG 11, CO 217, Vol. 34, p. 158, Hopson and Bastide, 12 June 1749.

71 "Le flanc gauche du bastion du Roy ... a aussi le deffaut d'etre plus elevé que la face gauche de ce bastion." AG, CTG, 14-1, 32.

72 C. Ochiltree MacDonald, The Last Siege of Louisbourg (London: Cassel, 1907), Preface, pp. XV-XVII.

73 AN, Outremer, DFC, IV-45, Profile de Louisbourg relatif au plan de la partie du port a fortiffier.

74 AN, F^3, 5, 213.

75 PAC, MG 18, K2, Gaspard Chaussegros de Léry, "Traite de fortification," p. 65.

76 Ibid., Preface (n.p.).

77 AG, CTG, 8-1, 1 (Montmédy); on-site inspection by author.

78 PAC, MG 18, K2, Gaspard Chaussegros de Léry, "Traite de fortification," pp. 52-54.

79 AN, Col. $C^{11}B$, Vol. 16, f. 183, Verrier to minister, 6 Nov. 1734.

80 AN, Col. B, Vol. 66, f. 285-88; AN, Col. $C^{11}B$, Vol. 20, f. 228, AN, Col. B., Vol. 68-2, f. 334.

81 AN, Col. $C^{11}B$, Vol. 28, p. 298.

82 Belidor, op. cit., Book 4, p. 57. See also the specific example of a pentagonal guérite detailed in the devis for Neuf Brisach which Belidor uses to demonstrate "la maniere de faire les devis," Book 4, p. 39.

83 Blaine Adams, op. cit.

84 "Il ne reste plus rien a faire maintenant du Corps de la place que le petit Chemin Couvert devant les Cazernes du Costé de la ville pour en cas doccasion mettre en Sureté la Porte de Cazernes et la gorge du Bastion du Roy, et pour donner un air de fort a ce Bastion...." AN, Col. $C^{11}B$, Vol. 20, f. 228.

The Dauphin Half-Bastion

1 Cf. the château-fort of Sedan, Fig. 21. For discussions on tenaille fronts, see de Ville, p. 139; for forked bulwarks, Ward, p. 51.

2 AN, Col. $C^{11}B$, Vol. 9, pp. 141-47, Verrier to minister, 17 Nov. 1727.

3 Verrier's earliest proposals in the form of a plan indicate the powder magazine close to the left shoulder angle, with the barracks further along the face to the right: AN, Outremer, DFC, IV-161 (1727). Later plans all show the relative positions of the buildings reversed.

4 AN, Col. $C^{11}B$, Vol. 20, p. 233, Verrier to minister, 1 Nov. 1738.

5 Ibid., Vol. 10, pp. 126-28, Verrier to minister, 27 June 1728.

6 Ibid., p. 82, St. Ovide to minister, 3 Nov. 1728; p. 110, Mézy to minister, 22 Nov. 1728; p. 134, Verrier to minister, 13 Nov. 1728.

7 Ibid., p. 240, Verrier to minister, 31 Aug. 1729.

8 Ibid., Vol. 12, pp. 104-9, Verrier to minister, 29 Nov. 1731.

9 Ibid., Vol. 17, p. 253, Verrier to minister, 28 Oct. 1735.

10 Ibid., Vol. 19, p. 232, Verrier to minister, 30 Oct. 1737.

11 Cf. ibid., Vol. 16, pp. 182-93, Verrier to minister, 6 Nov. 1734; ibid., Vol. 17, pp. 252-69, 28 Oct. 1735; ibid., Vol. 19, pp. 232-40, 30 Oct. 1737.

12 Ibid., Vol. 25, p. 19, Dusquesnel and Bigot to minister, 28 Oct. 1743.

13 Ibid., Vol. 21, p. 276, "Mémoire pour les ouvrages faits et a faire pour les fortiffications de Louisbourg et pour sa deffence." The document is undated and unsigned but appears in the correspondence of 1739; it is probable that it was one of the mémoires left by St. Ovide, the outgoing governor, to his successor Forant.

14 Ibid., Vol. 26, Duquesnel and Bigot to minister, 10 Oct. 1741.

15 "Si toute fois [il] convien de couvrir cette Porte, une Contregarde suffiroit afin de ne pas s'etendre dans la Campagne, et la disposition du flanc droit du Bastion du Roy battront la tranchée que l'ennemi feroit pour attaquer cet Ouvrage." AN, Col. $C^{11}B$, Vol. 26, Verrier to minister, 8 Feb. 1744.

16 "J'ay estimé pour le [the governor] guerir de la peur, prolonger le fossé de la face du Bastion Dauphin jusqu'a la mer, et la masse de terre qui restera devant la porte servira d'une espèce de lunette ... ce qui donnera un double feu sur le chemin couvert, et le flanc du Bastion du Roy deffendra le fossé et le glacis de toute la nouvelle piece, ce flanc ayant une superiorité de plus de vingt pieds ... Je ne toucheray cependant a rien sans avoir reçu vos ordres." AN, Outremer, DFC, p. 209, Verrier to minister, 18 Nov. 1744.

17 AN, Col. F^3, Vol. 50-1, p. 319, "Estat de la partie attaquée de la Ville de Louisbourg," 26 June 1745; ibid., pp. 368-81, "Sur la prise de Louisbourg," 1 Aug. 1745.

18 PAC, MG 11, CO 217, Vol. 28, pp. 192-3, Description and state of the Fortifications of Louisbourg, Knowles and Bastide, 8 July 1746.

19 PAC, MG 11, CO 217, Vol. 34, p. 157, "State and Condition of the Fortifications ... when the Place was returned to the French," Hopson and Bastide, 12 July 1749.

20 AN, Col. $C^{11}B$, Vol. 28, pp. 303-20.

21 For details on the career of Louis Fran-

quet, see Dictionary of Canadian Biography (Toronto: Univ. of Toronto Press, 1966-), Vol. 3.

22 AN, Col. C^{11}B, Vol. 31, p. 137, Franquet to minister, 9 Nov. 1751.

23 AN, Col. C^{11}A, Vol. 126, Franquet to minister, 20 Nov. 1751; cf. also AG, CTG, 14 & 15.

24 AG, CTG, 14-1-15, minister to Franquet, 15 March 1752.

25 Ibid., 15-8, p. 23, Mémoire pour le Sr. Franquet, Louisbourg 1758.

26 Wolfe's general orders, 30 June 1758, cited in McLennan, op. cit., p. 269.

27 Wolfe, cited in McLennan, op. cit., p. 269.

28 AG, CTG, Ms. reliés 210d, 75-117, "Journal des Evenements survenus à Louisbourg pendant l'année 1758."

29 Erosion in this area is not a recent phenomenon: a plan of the "fauxbourg de la Porte Dauphine" (AN, Col. C^{11}A, Vol. 126, p. 232, signed Verrier, 1740) shows a large section of the shore washed away by a recent storm.

30 PAC, MG 11, CO 217, Vol. 34, p. 157, "State and Condition of the Fortifications," Hopson and Bastide, 12 July 1749.

31 Cf. St. Georges Chapel, Sydney, N.S. (1793); warehouses and public buildings (18th-19th century) in waterfront area of Halifax, N.S.

32 PAC, MG 11, CO 217, Vol. 34, p. 157, "State and Condition of the Fortifications," Hopson and Bastide, 12 July 1749.

33 Ibid., Vol. 28, pp. 192-3, Description and state of the Fortifications of Louisbourg, Knowles and Bastide, 8 July 1746.

34 AG, CTG, 15-7, "Memoire sur Louisbourg," 1758.

35 "Le flanc gauche du Bastion Dauphin plus elevé de 4 pieds que la courtine se soutient de niveau ... La face gauche du dit Bastion dauphin est de niveau avec son flanc dans les 3/4 de sa longueur, et plus loing, est un ressault de 2 pieds jusqu'a son angle flanqué qui par ce moyen se trouve de 26 pieds plus bas que l'angle du bastion du Roy." AG, CTG, 14-1-33, Franquet's mémoire on the King's-Dauphin front, 1751.

36 AN, Col. C^{11}B, Vol. 28, p. 298.

37 Ibid., p. 304v.

38 Ibid., Vol. 11, p. 74v, Verrier to minister, 2 Dec. 1730.

39 Masonry to an average thickness of 8 pieds over a length of 44 toises, 3 pieds and 2 toises 2 pieds high was calculated; this included the parapet. Obviously, no interior revetment was allowed for.

40 The latest plan on which it appears is a plan of the proposed works for the quay dated 1734 and signed by Verrier: AN, Outremer, DFC, IV-180.

41 AN, Col. C^{11}B, Vol. 12, p. 227, St. Ovide to minister, 8 Jan. 1732.

42 Dimensions taken from Franquet's profile showing the cavalier as it existed and as he proposed to modify it, along with the rest of the front: AN, Col. C^{11}A, Vol. 126, pp. 154-56 (1751). See also Fig. 91.

43 See also discussion on parapets and embrasures for the King's Bastion.

44 PAC, MG 18, K2, Gaspard Chaussegros de Léry, "Traite de fortification," p. 56.

45 PAC, MG 11, CO 217, Vol. 27, pp. 263-70, "Some observations on the Situation, and Strength, of the Harbour and Town of Louisbourg, on the Island of Capp Briton, by John Eliot Surgeon to L$^{t.}$ General Phillip's Reg$^{mt.}$ Who was Prisoner there for six months," 1745.

46 AN, Col. C^{11}B, Vol. 28, p. 308.

47 Ibid.

48 PAC, MG 11, CO 217, Vol. 34, p. 157, "State and Condition of the Fortification," Hopson and Bastide, 14 July 1749.

49 AN, Col. C^{11}B, Vol. 28, p. 308.

50 Ibid. Refer also to discussion on embrasures for the King's Bastion, Appendix E.

51 This was a criticism made by Franquet in his initial tour of inspection in 1751: AN, Col. C^{11}A, Vol. 126, cf. also the mémoire (? by St. Ovide) on priorities to be completed: AN, Col. C^{11}B, Vol. 21, p. 276.

52 AN, Col. C^{11}B, Vol. 28, p. 308.

53 Belidor, op. cit.; PAC, MG 18, K2, Gaspard Chaussegros de Léry, "Traite de fortification," BG, Ms 131d (in folio), Claude Masse, "Mémoire ou traite fortification."

54 AN, Col. C^{11}B, Vol. 28, pp. 298v, 304.

55 Although Boucher in his estimates included calculations for the ramp retaining wall, the wording is such that repairs, rather than a new construction, appear to be be called for (ibid., p. 304v). It would thus be erroneous to conclude from his estimates that the wall did not yet exist and was later built by the French.

56 AN, Col. C^{11}A, Vol. 126, p. 123, "Mémoire sur l'état actuel des ouvrages," Franquet, 1756.

57 AG, CTG, 14-28, "Etat des Pavillons, Cazernes, Corps de garde," Franquet, 1751.

58 BG, Ms. 131d (in folio), Clause Masse, "Mémoire ou traité fortification." See also Charles Lindsay, "Louisbourg Guardhouses," Canadian Historic Sites: Occasional Papers in Archaeology and History, No. 12 (1975), pp. 47-100.

59 AG, CTG, 14-28, "Etat des Pavillons, Cazernes, Corps de garde," Franquet, 1751.

60 i.e. 1729-30. Cf. AN, Col. C^{11}B, Vol. 10, p. 82, St. Ovide to minister, 3 Nov. 1728; ibid., p. 134, Verrier to minister, 13 Nov. 1728; ibid., p. 240, Verrier to minister 31 Aug. 1729; ibid., Vol. 11, p. 14, de Bourville and C. Normant to minister, 20 July 1730.

61 For precautions on opening and entering powder magazines, see Surirey de St. Rémy, Memoires d'Artillerie (The Hague: 1741), Vol. 4, pp. 215-16.

62 The earliest plan -- a proposal before work had begun -- is the one exception, showing a hipped roof. See Fig. 160.

63 Belidor, op. cit., Book 4, pp. 62-72.

64 AN, Col. C^{11}A, Vol. 126, p. 7.

65 AN, Col. C^{11}B, Vol. 12, p. 77, Mézy to minister, 15 Nov. 1732.

66 Ibid., p. 265, St. Ovide to minister, 15 Nov. 1732.

67 Ibid., Vol. 23, pp. 191, 198, Verrier to minister, 26 Oct. 1741. See also Fig. 84.

68 AG, CTG, 14-4, undated plan (N.D. 69 in Louisbourg archival holdings).

69 AN, Col. F^{3}, Vol. 50, p. 287, Sur le Siège et la Prise de Louisbourg, 2 Sept. 1745.

70 PAC, MG 11, CO 217, Vol. 34, p. 157.

71 Refer to notes 33 and 49, this chapter.

72 Body sherd, Staffordshire slipware (mid-

18th century); body sherds, ironstone ware (late 19th century).

73 BN, CP, GeDD 2987, No. 8633.

74 Michigan. University. Wm. L. Clements Library. Thomas Gage Papers, "A Plan of Louisbourg," George Sproule, 1767.

75 AN, Col. C^{11}B, Vol. 10, p. 262v, Verrier to minister, 18 Dec. 1729.

76 Sussex Archaeological Society, Lewes, Peter Warren Papers, Vol. 1, p. 25, 5 Aug. 1745.

77 PRO, CO 5, Vol. 53, p. 369, "A Report of the Condition of the Works," Bastide, 13 Aug. 1758.

78 AN, Col. C^{11}B, Vol. 11, p. 14, de Bourville and Le Normant to minister, 20 July 1730.

79 Ibid., Vol. 13, p. 201, Verrier to minister, 16 Nov. 1732.

80 Cf. in particular Blomfield, op. cit., pp. 55-57 and illustrations opposite pp. 56, 57, 58, 61; cf. also Belidor, op. cit., Book 4, pp. 35-69, Pls. 13-19.

81 AN, Col. C^{11}B, Vol. 28, pp. 303v, 307-8.

82 Ibid., Vol. 11, p. 75, Verrier to minister, 2 Dec. 1730.

83 Ibid., Vol. 12, p. 104v, Verrier to minister, 29 Nov. 1731.

84 PAC, MG 11, CO 217, Vol. 34, p. 156.

85 AN, Col. C^{11}B, Vol. 28, p. 310v.

86 Ibid., Vol. 32, p. 262v, Boucher to minister, 18 Oct. 1752.

87 Ibid., p. 266v, Boucher to minister, 25 Nov. 1752.

88 PAC, MG 13, WO 34, Vol. 1, 11, Drucour to Amherst, 27 July 1758.

Curtain Walls

1 AN, Col. C^{11}B, Vol. 14, p. 299, Verrier to minister, 23 Oct. 1733.

2 "La courtine pend par ressaults rempants de 32 pieds vers le flanc gauche du bastion dauphin.... Le flanc gauche du Bastion Dauphin, plus elevé de 4 pieds que la courtine se soutient de niveau." AG, CTG, 14-1, pp. 31-33, "Mémoire sur le front de fortification," Franquet, 20 Nov. 1751.

3 Cf. Trincano, op. cit., p. 5; Muller, op. cit., pp. 28-29.

4 AN, Col. C^{11}B, Vol. 28, p. 304.

5 AG, CTG, 14-1, pp. 31-33, "Mémoire sur le front de fortification," Franquet, 20 Nov. 1751.

6 *See also* "The Dauphin Half-Bastion: Excavation of the Ramparts: Escarps." The discrepancy between Franquet's figures -- a 32-*pied* drop from the King's Bastion, a 4-*pied* rise to the left flank of the Dauphin Half-Bastion, and finally a rise of another 2 *pieds* along the face so that the flanked angle is 26 *pieds* below that of the King's Bastion -- and the archaeologically deduced elevations remains unresolved.

7 AN, Col. C^{11}B, Vol. 16, p. 185v, Verrier to minister, 6 Nov. 1734.

8 AG, CTG, 14-1, pp. 31-33, "Mémoire sur le front de fortification," Franquet, 20 Nov. 1751.

9 PAC, MG 11, CO 217, Vol. 34, pp. 157-58, Hopson and Bastide, 12 July 1749.

10 AN, Col. C^{11}A, Vol. 126, pp. 108-9, Franquet to minister, 4 Nov. 1755.

11 "Sa courtine a été conduite rempante de 8 pieds 9 pouces vers le flanc gauche du bastion du Roy...." AG, CTG, 14-1, pp. 31-33, "Mémoire sur le front de fortification," Franquet, 20 Nov. 1751.

12 AN, Col. C^{11}B, Vol. 28, p. 305 (also p. 328 for estimates of plank revetment).

13 Ibid., Vol. 12, p. 106v, Verrier to minister, 29 Nov. 1731. *See also* the reply: AN, Col. B, Vol. 57-2, p. 438, minister to Verrier, 19 June 1732.

14 AN, Col. C^{11}B, Vol. 14, p. 298v, Verrier to minister, 23 Oct. 1733.

15 Ibid., Vol. 15, p. 151, St. Ovide to minister, 4 Nov. 1734.

16 Ibid., Vol. 18, p. 13, St. Ovide and Le Normant to minister, 7 Nov. 1736.

17 Ibid., Vol. 28, p. 305.

18 Ibid., Vol. 12, p. 106v, Verrier to minister, 29 Nov. 1731.

19 Ibid., Vol. 14, p. 133, Le Normant to minister, 30 June 1733.

20 Ibid., Vol. 18, p. 296v, Verrier to minister, 8 July 1736.

21 Ibid., Vol. 9, p. 232, "Toisé provisionnel des Ouvrages," Verrier, 15 Nov. 1727.

Completion of the Landward *Enceinte*

1 AN, Col., C^{11}B, Vol. 19, p. 230v, Verrier to minister, 2 June 1737.

2 AG, CTG, 14-1, p. 31.

3 Ibid., "La Courtine a été conduitte rempante de 5 pieds 10 pouces vers le flanc gauche du Bastion de la Reine ... Le flanc gauche a aussy le default d'Etre plus elevé que la face suivante du dit Bastion de 2 pi. 9 pouces. Cette face gauche va aussy en montant de 2 pieds 4 pouces vers l'angle flanqué...." Ibid., p. 32, "La face droit du bastion de la Reine pend de 13 pouces vers son Epaule ... son flanc pend aussy de 8 pouces vers son angle avec la courtine; est plus elevée de 14 pouces, que la face precedente...."

4 PAC, MG 11, CO 217, Vol. 34, p. 159, Hopson and Bastide, 12 July 1749. *See also* the various British plans drawn during the occupation, most based on an original by Bastide (e.g. the Pettigrew copy: PRO, CO 5, Vol. 13, p. 205).

5 PAC, MG 11, CO 217, Vol. 34, p. 131, Hopson and Desherbiers, 10 July 1749.

6 AN, Col. C^{11}B, Vol. 29, pp. 266-67, Boucher to minister, 29 Sept. 1750.

7 Ibid., pp. 269-75, "Toisé definitif," 15 Nov. 1750.

8 70 *toises*, as opposed to 72 *toises* for the King's-Queen's curtain, according to Boucher: ibid., Vol. 28, p. 305.

9 Ibid., Vol. 18, p. 269v, Verrier to minister, 8 July 1736; AN, Outremer, DFC, IV, p. 186.

10 AN, Col. C^{11}B, Vol. 20, p. 228, Verrier to minister, 1 Nov. 1738.

11 Ibid., Vol. 28, p. 305.

12 Ibid., Vol. 16, p. 182v, Verrier to minister, 6 Nov. 1734.

13 Ibid., Vol. 23, p. 179, "Estat des Canons necessaires," Bigot, 9 Oct. 1741.

14 Ibid., Vol. 18, pp. 46-47, St. Ovide to minister, 30 Oct. 1736.

15 Ibid., p. 278, Verrier to minister, 10 Nov. 1736.

16 Ibid., Vol. 25, p. 19v, Duquesnel and Bigot to minister, 28 Oct. 1743.

17 PAC, MG 11, CO 217, Vol. 28, p. 193, Knowles and Bastide, July 8, 1746.

18 AN, Outremer, DFC, n^{o} d'ordre 209, Verrier to minister, 18 Nov. 1744.

19 PAC, MG 11, CO 217, Vol. 34, p. 160,

Hopson and Bastide, 12 July 1749; *see also* Boucher's report, AN, Col. C^{11}B, Vol. 28, p. 299.

20 RUS, VH-9, "Plan of the Town & Fortress of Louisbourg," John Henry Bastide, 1745.

21 PAC, MG 11, CO 217, Vol. 34, p. 160.

22 Margaret Fortier, "Princess Bastion Report," manuscript on file, FLNHP, 1966. I am grateful to Mrs. Fortier for her exhaustive research into primary sources which greatly facilitated preparation of the interpretation presented above.

23 Bruce W. Fry, "A Rescue Excavation at the Princess Half-Bastion," *Canadian Historic Sites: Occasional Papers in Archaeology*, No. 2 (1971), pp. 46-54.

24 Prince Chitwood, "Salvage Excavation of the Seaward Side of the Princess Demi-Bastion," manuscript on file, FLNHP, 1977.

The Landward Defences: Outworks

1 For example, the glacis and parapet of the covered way from the flanked angle of the Princess Bastion up to the flanked angle of the King's Bastion, to be carried out in 1738 along with continuing excavation of the ditch in front of the King's-Queen's curtain. AN, Col. C^{11}B, Vol. 19, f. 235, Verrier to minister, 30 Oct. 1737.

2 Ibid., Vol. 11, f. 80, Verrier to minister, 26 March 1730; ibid., ff. 14-15, de Bourville and Mézy to minister, 20 July 1730; ibid., ff. 16-22, de Bourville and Mézy to minister, 3 Dec. 1730; ibid., Vol. 21, f. 276, "Mémoire," unsigned and dated 1739 only (presumed to have been written by St. Ovide to Forant).

3 Ibid., Vol. 22, f. 61, Verrier to minister, 25 Oct. 1740.

4 AN, Col. C^{11}A, Vol. 126, f. 164v, "Mémoire sur le front de fortification," Franquet, 24 Nov. 1751.

5 PAC, MG 11, CO 217, Vol. 28, p. 197, Knowles and Bastide, 8 July 1746.

6 AN, Col. C^{11}B, Vol. 20, ff. 228-29v, Verrier to minister, 1 Nov. 1738; ibid., Vol. 21, ff. 344-45, Verrier to minister, 2 Aug. 1739.

7 Ibid., Vol. 24, f. 213, Verrier to minister, 9 Nov. 1742.

8 Ibid., Vol. 11, f. 74v, Verrier to minister, 2 Nov. 1730; ibid., Vol. 12, f. 104v, Verrier to minister, 29 Nov. 1731; ibid., Vol. 20, f. 228, Verrier to minister, 1 Nov. 1738.

9 BN, CP, 23271, Atlas, Ge BB 563 (1).

10 AN, Col. C^{11}B, Vol. 7, f. 136, Verrier to minister, 17 Nov. 1724.

11 Ibid., Vol. 9, f. 239v, Verrier's *toisé provisionnel*, Nov. 1727.

12 PAC, MG 11, CO 217, Vol. 34, pp. 156-57, Hopson and Bastide, 12 July 1749; AN, Col. C^{11}B, Vol. 28, f. 298, Boucher to minister, 24 July 1749; ibid., f. 303v-310v, "Estimation des Reparations," Boucher, 30 Aug. 1749.

13 PAC, MG 11, CO 217, Vol. 28, pp. 196-97, Knowles and Bastide, 8 July 1746.

14 AN, Col. C^{11}A, Vol. 126, f. 188, "Sur l'état des ouvrages," Franquet, 20 Nov. 1751; ibid., C^{11}B, Vol. 31, f. 145, "Mémoire sur le front de fortifications," Franquet, 20 Nov. 1751.

15 AN, Col. C^{11}B, Vol. 36, f. 249v, Franquet to minister, 20 April 1756.

16 AN, C^{11}A, Vol. 126, f. 116, Franquet to minister, 4 Nov. 1755.

17 For variants on tenaille design, *see* John Muller, op. cit., pp. 33-35, Pl. 2.

18 AG, CTG, 15-17 (n.p.), "Mémoire sur Louisbourg en l'Isle Royale," Franquet, 1758 (no other date).

19 AN, Col. C^{11}A, Vol. 126, f. 124, "Mémoire sur l'Etat actuel des ouvrages," Franquet, 1756 (no other date).

20 AN, Col. C^{11}B, Vol. 36, f. 258v, Franquet to minister, 10 Aug. 1756.

21 Ibid., ff. 280-281v, Franquet to le Garde des Sceaux, 25 June 1756.

22 PRO, CO 5, Vol. 53, f. 382, "A Report of the Condition of the Works," 13 Aug. 1758.

23 AN, Col. F^{3}, 15 (2), f. 390.

24 AN, Col. C^{11}B, Vol. 36, f. 257v, Franquet to minister, 10 Aug. 1756; AG, CTG, 15-18 (n.p.), "Mémoire pour le Sieur Franquet, 1758" (unsigned).

25 RAI, Bk. 10, "A Journal containing the manner, method, and Execution of the Demolition of the Fortifications of Louisbourg, from June 1st to November 10th A.D. 1760."

26 AN, Col. C^{11}B, Vol. 28, f. 298, Boucher, 25 July 1749, translation by author.

27 Ibid., Vol. 33, f. 229v, Franquet to minister, 9 Oct. 1753.

28 Ibid., Vol. 28, f. 303v, "Estimation des Reparations," Boucher, 30 Aug. 1749.

29 Ibid., 310v.

30 Cf. Belidor, op. cit., Book 3, pp. 55-58, Pl. 8.

31 Franquet gave a detailed description of "barrières" for closing the sally-ports of *place d'armes* in a *mémoire* on the subject: AN, Col. C^{11}B, Vol. 31, ff. 162-172v, 15 Dec. 1751. The accompanying illustration (reproduced in APT, Vol. 4, Nos. 1-2 [1972], Fig. 88) is useful in that it gives a visual impression of what such gates would have looked like: pickets affixed to two transverse bars with one diagonal reinforcing bar. However, it is not clear where these were intended to be placed as the dimensions are for an entrance 12 *pieds* wide, twice that of the sally-port in question, and the gate is two-leafed. The smaller, single-leaf gate he also describes is specifically mentioned as a barrier across the restricted covered way between a traverse and the revetment wall nearby.

32 AN, Col. C^{11}B, Vol. 31, f. 157-172v.

33 Ibid.

34 Ibid.

35 AN, Col. C^{11}A Vol. 126, ff. 68-69, Franquet and Raymond to minister, 25 May 1752. *See also* f. 116v, Franquet to minister, 4 Nov. 1755. It is not easy to know with certainty to what species of trees the French referred; several of the terms are no longer in use in modern Frnch, while Acadian and Québecois connotations are not always the same. The two best sorts of wood, *chêne* (oak) and *cèdre* (cedar), present no problems, but were costly or impossible to obtain. The other species cause some confusion. Franquet refers to *prusse*, *héricot* and *épinette*. The following applications of the terms are in use today:

English	Acadian	Québecois
hemlock	haricot	pruche
spruce	pruce	épinette
fir (balsam)	épinette	sapin

The 1752 document is divided into two columns, the left one being signed by Franquet, the right by Raymond. The latter notes that "L'espece qu'on nomme hericot à Louisbourg, et prusse en Canada" may be used if cedar cannot be obtained, but in the 1755 report, Franquet spoke of using "prusse" and "héricot" together. To confuse the issue still further, Raymond distinguishes between "épinette blanche" and "épinette rouge." The latter, he says, is what is known in France as "Mélèze," generally taken to be larch (but also used to refer to tamarack and juniper in Acadian and Québecois).

36 AN, Col. $C^{11}C$, Vol. 16, St. Julhien to minister, 20 Sept. 1757.

37 FLNHP design files, memorandum to construction manager, J. Lunn, 8 April 1969.

Enclosing the Town

1 AN, Col. B, Vol. 65, f. 275, minister to Verrier, 6 May 1737; ibid., f. 471v, same instructions conveyed to St. Ovide and Le Normant.

2 AN, Col. $C^{11}B$, Vol. 19, ff. 244-46, Verrier to minister, 24 Oct. 1737.

3 Ibid., Vol. 18, ff. 277v-78, Verrier to minister, 20 Nov. 1736.

4 AN, Col. B, Vol. 66, f. 286v, minister to de Bourvillile and Le Normant, 29 April 1738; ibid., f. 289, same instructions written to Verrier.

5 AN, Col. $C^{11}B$, Vol. 22, ff. 7v-10, Verrier to minister, 29 Oct. 1740; ibid., ff. 258v-260; ibid., ff. 60-65, Bigot and de Bourville to minister, 29 Oct. 1740.

6 Ibid., Vol. 23, ff. 187-188; Verrier to minister, 3 June 1741.

7 Ibid., f. 189, Verrier to minister, 23 Aug. 1741.

8 Ibid., Vol. 24, ff. 210v-11, Verrier to minister, 20 Aug. 1742.

9 "Jose vous assurer Monseigneur, que les fortiffications de Louisbourg seront en son Entiere perfections, La Ville fermée de tous Costés et la garnison en Etat de se bien deffendre sy les munitions de guerre et de bouche ne manquent pas, et que l'on envoye une augmentaiton de trouppes reglée." Ibid., ff. 215, Verrier to minister, 9 Nov. 1742.

10 Belidor, op. cit., Book 3, pp. 50-52, pl. 8.

11 AN, Col. $C^{11}A$, Vol. 126, f. 78, "La Porte de la Nouvelle Enceinte de Louisbourg," Verrier, 1739.

12 AN, Outremer, DFC, IV-195, unsigned drawing accompanying Verrier's letter of 29 Oct. 1740.

13 McLennan, op. cit., p. 170.

14 AN, $C^{11}A$, Vol. 126, f. 51, Rouillé to Franquet, 15 March 1752.

15 AN, Col. $C^{11}B$, Vol. 28, ff. 299v-300, "Etat des fortiffications," Boucher, 24 July 1749.

16 AG, CTG, 14-1-36, "Mémoire sur le front ... Maurepas ... Brouillan," Franquet, 20 Nov. 1751.

17 Ibid., 14-1-35, "Mémoire sur la Pièce de la Grave."

18 AN, F^3, Col. 50, f. 40v, "Remarques sur les avantages des trois postes," 1716 (unsigned), AN, Col. $C^{11}B$, Vol. 1, f. 307v, minutes of *Conseil de Marine* (Louvre), 14 March 1716.

19 AN, Col. B, Vol. 39, ff. 268-69, Conseil to Verville, 3 June 1717.

20 AG, CTG, 14-1-17, "Plan de la ville de Louisbourg avec les alignements des rues," Verville, 1722.

21 AN, Col. $C^{11}B$, Vol. 12, ff. 114-18, "Mémoire concernant l'Etablissement du Quay de la ville de Louisbourg," Verrier to minister, 29 Nov. 1731.

22 Ibid., Vol. 22, pp. 7v-10, Verrier to minister, 29 Oct. 1740.

23 Ibid., Vol. 24, f. 210, Verrier to minister, 20 Aug. 1742.

24 Ibid., Vol. 31, f. 177, "Mémoire sur l'Etat du front de face au Port," Franquet, 20 Nov. 1751.

25 This figure appears to include the parapet, but it is not clear how much height was to be added to the original feature, which must have stood to a total height of 16 to 18 *pieds* above its foundations.

26 Surprisingly little documentation exists on the Frederick Gate in comparison with the other gates of the town. The view by Verrier (Fig. 85) is the only source concerning construction material. The use of wood is clearly evident from the nailing pattern indicated on the drawing and the framework in the roof. How the roof was covered is less certain; shingles are indicated but could be of wood or slate. The blue colour used on the original drawing is the same used by Verrier to indicate slate roofs on King's buildings elsewhere in Louisbourg.

27 AN, Col. $C^{11}B$, Vol. 28, f. 300; Boucher, 24 July 1749.

28 Ibid., Vol. 31, f. 177v, "Mémoire sur l'Etat du front," Franquet, 20 Nov. 1751.

29 Ibid., Vol. 31, ff. 152-54, "Mémoire sur les Cales, et sur le Quay," Franquet, 14 Dec. 1751; ibid., Vol. 36^{e}, f. 254v, Franquet to minister, 14 July 1756; ibid., f. 256f, Franquet to minister, 10 Aug. 1756.

30 For details on lime mortar and its preparation at Louisbourg, *see* Charles S. Lindsay, "Lime Preparation at 18th-Century Louisbourg," *Canadian Historic Sites: Occasional Papers in History and Archaeology*, No. 12 (1975), pp. 5-45.

Harbour Defences

1 BN, CP, S.H., 131-11-1, "Plan du Havre de Louisbourg," L'Hermitte, 28 Dec. 1716.

2 AN, Outremer, DFC, IV-152, "Plan de la Batterie Royale ... pour servir au projet de 1726," Verrier, 1725. *See also* Fig. 228.

3 AN, Col. $C^{11}B$, Vol. 6, ff. 298-308v, "Devis de la Grande Batterie," Verville, 8 Aug. 1723.

4 Ibid., ff. 184-184v, St. Ovide to minister, 22 Nov. 1723.

5 Ibid., Vol. 7, ff. 136-137v, Verrier to minister, 17 Nov. 1724; ibid., Vol. 10, ff. 109-111v, Mézy to minister, 22 Nov. 1728.

6 AN, Col. B, Vol. 53, ff. 602v-606, minister to Verrier, 22 May 1729.

7 AN, Col. $C^{11}B$, Vol. 12, ff. 104-109v, Verrier to minister, 29 Nov. 1731.

8 The number of troops stationed at the Royal Battery varied considerably. Official instructions were for one of the eight

companies serving at Louisbourg to occupy the battery for a year, then to be relieved by another company (i.e. 70 men) -- AN, Col. B, Vol. 52-2, ff. 578v-579v, minister to St. Ovide and Le Normant, 27 June 1732. In reality, only 15-20 men seemed to have been there for most of the time: AN, Col. C^{11}B, Vol. 18, f. 126, Le Normant to minister, 20 Dec. 1736. Immediately prior to the first siege, nearly 20 men were located in the battery, but this included an unspecified number of fishermen and other civilians: AN, Col. C^{11}B, Vol. 27, ff. 41-43v, Verrier to minister, 22 Aug. 1745.

9 BG, Ms 131d (in folio), Claude Masse, "Mémoire ou traite fortification."

10 Reproduced in Michel Parent and Jacques Verroust, Vauban (Paris: Jacques Fréal, 1971), p. 118.

11 AN, Col. C^{11}B, Vol. 9, ff. 60-63v, St. Ovide to minister, 17 Nov. 1727.

12 AN, Col. B, Vol. 51-2, ff. 588-592v, minister to Verrier, 20 June 1728.

13 AN, Col. C^{11}B, Vol. 10, ff. 81-84, St. Ovide to minister, 3 Nov. 1728.

14 Ibid., ff. 131-140, Verrier to minister, 13 Nov. 1728.

15 AN, Outremer, DFC, IV-159, "Plan de la Batterie Royalle" (1727), with annotation "Projet de 3 embrasures pour augmenter la deffence."

16 AN, Col. C^{11}B, Vol. 18, ff. 271-283, Verrier to minister, 10 Nov. 1736.

17 Ibid.

18 AN, Outremer, DFC, Am. Sept. Numero d'Ordre 202, Verrier, 30 Oct. 1744.

19 AN, Col. C^{11}B, Vol. 28, ff. 301-301v, 312v-314v, Inspection & estimates, Boucher, 24 July 1749.

20 AN, Col. C^{11}B, Vol. 26, ff. 199-202, Verrier to minister, 8 Feb. 1744. For the provisional toisé of this work, see AN, Outremer, DFC, No. 202.

21 AN, Outremer, DFC, Am. Sept. Numero d'Ordre 209, Verrier to minister, 18 Nov. 1744.

22 AN, Col. B, Vol. 63, ff. 543v-547, minister to Verrier, 25 April 1735.

23 AN, Col. C^{11}B, Vol. 17, ff. 17-20, St. Ovide and Le Normant to minister, 28 Oct. 1735.

24 Ibid., Vol. 28.

25 Ibid., Vol. 22, ff. 27-28, Forant to minister, 8 Feb. 1740.

26 Ibid., ff. 252-252v, Verrier to minister, 7 Feb. 1740.

27 Ibid. See also AN, Outremer, DFC, IV-193C, "Plan de la Batterie Royalle ou on a representé en couleur jaune le petit Bastion projetté pour flanquer les faces de la ditte Batterie," Verrier, 1740.

28 AN, Outremer, DFC, 209.

29 AN, Col. C^{11}B, Vol. 27, f. 42, Verrier to minister, 22 Aug. 1745.

30 For an account of this episode, see G.A. Rawlyk, op. cit., Chap. 8, "The Taking of the Grand Battery."

31 AG, CTG, 14-1-38, "Mémoire sur la Batterie Royalle," Franquet, 20 Nov. 1751.

32 Ibid.; also ibid., No. 45, Franquet's reply to minister's queries, 25 May 1752.

33 AN, Col. B, vol. 80-1, Drucour to Destouttes, 8 June 1758.

34 RAI, Book 10, "Journal of the Demolition," p. 189.

35 J. Russell Harper, op. cit., pp. 308-9.

36 FLNHP, memorandum on file (325-1), John H. Rick to Project Manager, 26 March 1962; ibid., file 321-2 (22/7-R1), John H. Rick to Chief, National Historic Sites Division, 7 Nov. 1961; ibid., Chief, Historic Sites to Director, National Parks Branch, 9 Nov. 1961.

37 FLNHP, progress report on file, Vol. 1, Project Manager to Director, National Parks Branch, 22 May 1962.

38 AN, Col. C^{11}B, Vol. 6, ff. 178-180v, St. Ovide to minister, 22 Nov. 1723.

39 Ibid.

40 Ibid., ff. 182-186, St. Ovide, 22 Nov. 1723.

41 Ibid., f. 116, Verrier to minister, 1 Dec. 1726.

42 "M. Verrier ne s'est pas tout à fait attaché au plan que M. de Verville en avoit fait et il nous a pareu quil en a tiré le party le plus avantageux quil luy estoit possible." Ibid., Vol. 9, f. 32, St. Ovide and Mézy to minister, 26 Nov. 1727.

43 AN, Outremer, DFC, IV-55, "Plan de la Batterie de L'Isle de l'entrée pour servir au projet de 1727," Verrier, 1726. See also the plan and profile for the following year: ibid., 162. These and later plans are published in APT, Vol. 4, Nos. 1-2 (1972), Figs. 97-103.

44 AN, Col. C^{11}B, Vol. 10, ff. 131v-132, Verrier to minister, 13 Nov. 1728.

45 Ibid., Vol. 17, f. 18, St. Ovide and Le Normant to minister, 28 Oct. 1735.

46 Cf. AN, Col. C^{11}B, Vol. 16, f. 7, Sabatier to minister, 30 Nov. 1734; ibid., Vol. 17, f. 252v, Verrier to minister, 28 Oct. 1735; AN, Col. B, Vol. 64, ff. 463-463v (Enregistrement des Depeches concernant l'Isle Royale), minister to St. Ovide and Le Normant, 24 Jan. 1736.

47 AN, Col. C^{11}B, Vol. 28, ff. 301v-302, "Etat des fortiffications ... L'isle de l'Entree," Boucher, 24 July 1749.

48 AG, CTG, 14-1-27, "Mémoire sur la Batterie de L'islot," Franquet, 30 April 1751. For the plans accompanying the proposed additions, see AN, Col. C^{11}A, Vol. 126, ff. 152, 153 (a copy of the mémoire is also in this volume, ff. 216-18).

49 For an account of the attempt against the Island Battery, see G.A. Rawlyk, op. cit., pp. 126-30. See also Raymond F. Baker, op. cit., pp. 32-34.

50 PAC, MG 11, CO 217, Vol. 28, p. 191, "State of the fortifications," Knowles and Bastide, 8 July 1746.

51 AG, CTG, 14-1-54, "Mémoire pour le Sr. Franquet," 1758. See also ibid., 52, "Mémoire des Ouvrages faits dans le courant de cette campagne," Franquet 1757.

52 AN, Col. C^{11}B, Vol. 38, ff. 11-11v, Drucour and Prevost, 7 July 1758.

The Sieges

1 For the first siege: Raymond F. Baker, op. cit.; J.S. McLennan, op. cit., pp. 128-65; G.A. Rawlyk, op. cit. For the second siege: J.S. McLennan, op. cit., pp. 236-89. For a detailed discussion of the landing, see J. Mckay Hitsman and C.C.J. Bond, "The Assault Landing at Louisbourg, 1758," Canadian Historical Review, Vol. 35, No. 4 (Dec. 1954), pp. 314-30.

2 Raymond F. Baker, op. cit., pp. 7-13.

3 Ibid., p. 24.

4 "Fauxbourg de la Porte Dauphine" appears on several plans of the town and harbour; hence, although correct usage in modern French would be faubourg, the archaic form is retained for the purposes of this report.

5 Raymond F. Baker, op. cit., p. 30.

6 Ibid.

7 J.S. McLennan, op. cit., p. 263.

8 Wolfe's Orders, 30 June 1758, as cited in J.S. McLennan, op. cit., p. 269.

9 Ibid., pp. 267-68, 171-72, 274-75, 278, 280-84.

10 Ibid., pp. 276-78.

11 Obviously, there is a nice balance to be maintained between keeping the defenders on the qui vive and in overextending the manpower and supplies available to conduct an effective siege. Thus Vauban warned against opening fire from siege batteries too soon and too far away, or of wasting ammunition unnecessarily where no attack would develop: Marechal de Vauban, Attaque des Places, p. 89.

12 AN, Col. C, C^{11}B, Vol. 38, ff. 79-81, Durcour's Siege Journal (includes copies of letters to and replies from the British commanders, 6-8 July, 1758).

13 J.S. McLennan, op. cit., p. 276.

14 C.P. Stacey, Quebec, 1759: The Siege and the Battle (Toronto: MacMillan, 1959), pp. 64-65.

Conclusions

1 "Il faut crespir les Murs tous les trois ans, la dureté du climat faisant tomber les crespissages ce qui dégrade les joints, les parements, le Moillon etant très baroque, ne pouvant faire les joints ni les lits aussi quarrés qu'ils se font par tout ailleurs ... le climat de l'Isle Royale est très dur, ... le temps y change facilement plusieurs fois par jour, car il arrive souvent qu'il neige abondamment, le moment d'après il pleut à verse et dans la même heure il gèle à pierre fendre; ce sont ces gelées qui viennent après les pluyes qui gonflent les murs, et qui les écartent à ne pouvoir se soutenir." AN, Col. C^{11}B, Vol. 21, ff. 271-279, "Memoire pour les ouvrages faits et à faire pou[illegible]ortiffications de Louisbourg et po[illegible] deffence," anon., n.d. (1739). This document is classified with Verrier's correspondence, but it seems highly unlikely that he was the author, as many of the recommendations were specifically contrary to his point of view. Cross-reference to other correspondence suggests that the author was in fact the departing governor, St. Ovide, summarizing a list of priorities and problems for his successor, Forant.

2 PAC, MG 11, CO 217, Vol. 28, Knowles and Bastide, "State of the Fortifications," 8 July 1746.

3 AN, Col. C^{11}B, Vol. 36, ff. 263-267, Franquet to minister, 6 Dec. 1756.

4 AN, Col. C^{11}C, Vol. 16-2, ff. 221-240, St. Julhien to minister, 20 Sept. 1757.

5 AN, Col. C^{11}B, Vol. 38, f. 91, Drucour's Siege Journal; BG, Ms. in folio 66, f. 75v, Grillot de Poilly's Siege Journal.

6 F.J. Thorpe, op. cit., passim. Chaps 1 and 8 in particular develop this argument.

7 Larousse du XX^{e} Siècle: "Le mot 'forteresse' est longtemps peu usité dans le langage militaire français, où l'on employait et où l'on emploie encore de préférence le terme de 'place forte' pour désigner une ville entourée de fortifications, et celui de 'fort' pour indiquer un ouvrage établi à l'écart de tout centre de population. C'est surtout après la guerre franco-allemande de 1870 qu'on s'est servi en France, du terme de 'forteresse', plutôt pour qualifier les troupes ou les armes qui servent à l'attaque ou à la défense des places fortes, que pour désigner les places mêmes...."

8 Francis Parkman, A Half Century of Conflict (New York: Collier Books, 1962), pp. 290-96; 310-26; idem., Montcalm and Wolfe (New York: Collier Books, 1962), pp. 385-407; W.J. Eccles, The Canadian Frontier, 1534-1760 (New York, Holt, Rinehart and Winston, 1969), pp. 151, 154, 177-78.

9 Lt. Col. Cornet, "Mont Louis, création de Vauban," Revue Historique de L'Armée (Ministère de la Défense Nationale) No. 2 (1971), pp. 21-37.

10 Today little survives of the fortifications: the sea-wall, frequently indented to provide flanking fire as it follows the outline of the coast and the mole around the harbour are still preserved, as is the Fort Carré, but the landward defences have disappeared.

11 Francis Parkman, A Half-Century of Conflict (New York: Collier Books, 1962), p. 293.

12 Marcel Trudel, Introduction to New France (Toronto: Holt, Rinehard and Winston, 1968), p. 128.

13 Samuel Wilson, Jr., Bienville's New Orleans (New Orleans: Friends of the Cabildo, 1968), p. 15 and plan opposite.

14 F.J. Thorpe, op. cit., pp. 15, 146, 150.

15 A detailed history of the Quebec fortifications, co-authored by André Charbonneau, Yvon Deloges and Marc Lafrance, has recently been published. The present writer was responsible for the 1973-78 excavations of the Redoute Dauphine and the ramparts of existing Quebec City.

16 F.J. Thorpe, op. cit., p. 28.

17 AN, Col. F^{3}, Vol. 51, pp. 95-96, Mémoire du Conseil, 3 July 1717.

18 This theme is first propounded by J.S. McLennan, op. cit., p. 51, who uses the well-preserved entrenchments around Flat Point to support his argument. It is taken up by F.J. Thorpe, op. cit., pp. 10-11.

19 F.J. Thorpe, op. cit., pp. 316-17.

20 Margaret Fortier, "The development of the fortifications at Louisbourg," Canada: An Historical Magazine, Vol. 1, No. 4 (June 1974), p. 19.

21 "L'on est Jusqu'à présent attaché à faire un bastion pour deffandre la terre qui ne peut être attaquée, quaprés que L'ennemy ce sera emparé du port, ce qui luy seroit impossible aujourdhui, sy l'on avoit commancé de faire des Batteries en dedans du havre .... il ne scauroit absolumment Executé ce dessein [an attack on the town] par les difficultés des chemins qui ne sont que des montagnes escarpées; des Rochers; des fondrières de sapinages presque impracticables mesme par le gens du pays, qui ne scauroient sen tirer quavec peine." AN, Col. C^{11}B, Vol. 6, ff. 178-

180v, St. Ovide to minister, 22 Nov. 1723.

22 "Il faut faire une contregarde devant la Porte Dauphine, cette Porte etant entièrement découverte ... cette contrearde serviroit d'ailleurs a la deffense du Port et à empêcher que les Ennemis puissent s'établir aux environs du Martisens." AN, Col. C^{11}B, Vol. 21, f. 276, "Mémoire pour les ouvrages faits et à faire," anon., n.d. (1739), probably written by St. Ovide.

23 "qu'il ne les [the walls on either side of the gate] avoit fait, ainsi que la porte dauphine, que pour resister a la mousqueterie; je n'aurois pas cru qu'il fut convenu de faire au roy une dépense pareille à celle quil a fait, pour mettre cette ille à l'abri seulement du coup de fusil." AN, Col. F^3, Vol. 50, pp. 374-5, Bigot, 1 Aug. 1745.

24 AN, Col. C^{11}B, Vol. 21, f. 278, "Mémoire pour les ouvrages faits et à faire."

25 John Muller, op. cit., pp. 201-2.

26 AG, CTG, 14-1-32, "Mémoire sur le front de fortification," Franquet, 20 Nov. 1751.

27 Raymond Baker, op. cit., p. 25.

28 AG, CTG, 14-1-45, minister to Franquet, 15 March 1752.

29 Christopher Duffy, op. cit., p. 38.

30 AG, CTG, 14-1-43, "Mémoire ... sur les materiaux...," Franquet, 20 Nov. 1751.

31 AN, Col. F^3, Vol. 51, f. 60.

32 For a listing of various sieges and their duration, see David Chandler, op. cit., App. 3, pp. 308-10.

Appendix B. The Franquet Mémoires.

1 "L'on n'a fait dans ce premier Projet, que Corriger les defauts de la Fortification, et de Proposer par des ouvrages en augmentation sans detruire aucun des antans, une Egalité de deffence aux quatre Fronts quil comprend. A cet effet l'on a epaissi toutes les Parties qui se trouvoient trop Foibles pour resister au Canon...." AG, CTG, 14-1-30, 31, 32.

Appendix C. Calculations to Determine the Original Elevation of the Terreplein of the King's Bastion Ramparts.

1 Belidor, op. cit., Book 3, 81-82.

2 AN, Col. F^3, 51, 197, 10 June, 1718.

Appendix E. Calculations to Determine the Dimensions of the King's Bastion Embrasures.

1 AN, Col. C^{11}B, Vol. 28.

2 Trincano, op. cit., p. 386.

3 Philips, op. cit., p. 85.

4 "Le flanc gauche du bastion du Roy ... a aussi le deffaut d'etre plus elevé que la face gauche de ce bastion...." AG, CTG, 14-1-32, "Mémoire sur le front de fortification," Franquet, 24 Nov. 1751.

Illustration Sources

Cover BN, CP, Service Hydrographique, 131-11-6.

9 BG, Atlas 106, Vol. 2, uncat.

10 Ibid., No. 133.

11 BG, Atlas 96, "Flandres, 1602-19," No. 18.

13 Ibid., No. 6.

14 Ibid., No. 7.

15 BG, Atlas 104, "Recueil des plans de Villes ... 2^e classe, 1567-1686," No. 50 (1676).

21 BG, Atlas 105, "Recueil des blans [sic] de villes de France, de Flandres et de Hollande, 1667-86," No. 2.

23 BG, Atlas 100, "Picardy, 1640-50," No. 14.

24 BG, Atlas 99, "Recueil des Places Fortes, 1604-40," No. 21.

29 BG, Atlas 102, "Recueil des plans: Picardy, Artois, Hainault, Flanders," de Clerville.

31 BG, Atlas 106, "Sièges, camps, batailles, 1589-1689," Vol. 2, No. 108.

32 BG, Atlas 131g, "Recueil de plans de la Rochelle," Claude Masse, 1728.

42 BG, "Atlas ou Recueil de Ville et Citadelle de Verdun," No. 20 (1775).

46 BG, Atlas 96, "Flandres, 1602-19," No. 14.

47 BG, Atlas 104, "Recueil de plans de Villes ... 2^e classe, 1567-1686," No. 53.

48 BG, "Atlas du Quesnoy, 1778," No. 5.

58 BG, Atlas 106, "Sièges, camps, batailles, 1589-1689," No. 161.

59 Ibid., No. 152.

63 AG, CTG, 14-1-7.

65 BN, Cabinet des Estampes, Vd. 20a.

66 AN, Outremer, DFC, IV-245.

67 Ibid., IV-145.

69 AN, Col., C^{11}A, Vol. 126, f. 251.

70 AN, Outremer, DFC, IV-160.

71 BN, CP, c. 15980.

72 AG, CTG, 14-1-14.

73 AN, Outremer, DFC, IV-164.

74 Ibid., IV-175.

75 Ibid., IV-173.

76 Ibid., IV-176.

77 Ibid., IV-184.

78 AN, Col., C^{11}A, Vol. 126, f. 226.

79 AN, Outremer, DFC, IV-190.

80 Ibid.

81 AN, Col., C^{11}A, Vol. 126, f. 233.

82 AN, Outremer, DFC, IV-196.

83 Ibid., IV-194.

84 AG, CTG, 14-1-5.

85 Ibid.

86 RUS, VH-9, "Plan of the Town & Fortress of Louisbourg," John Henry Bastide, 1745.

87 Ibid., 14-1-30.

88 AN, Outremer, DFC, IV-225.

89 Ibid.

90 AN, Col., C^{11}A, Vol. 126, ff. 184-86.

91 Ibid., ff. 154-56.

92 AG, CTG, 14-1-32.

93 AN, Col., C^{11}A, Vol. 126, ff. 213-15.

94 AN, Outremer, DFC, IV-226.

95 AN, Col., C^{11}A, Vol. 126, f. 201.

96 Ibid., f. 103.

97 Ibid., f. 122.

98 Ibid., f. 259.

99 Ibid., f. 260.

100 AN, Outremer, DFC, IV-231.

101 AG, CTG, 14-19.

102 RUS, "Plan and Profil [sic] of the Mines for the Demolition of the Fortifications of Louisbourg completed the 8th of November 1760," François de Ruvygnes.
104 FLNHP, L 901-1.
111 AN, Outremer, DFC, IV-247.
113 AG, CTG, 14-1-13.
114 Ibid., 14-1-19.
115 AN, Outremer, DFC, IV-150.
116 Ibid.
117 BN, Cabinet des Estampes, Vd. 20a-56.
118 AG, CTG, 14-tablette 8.
119 AN, Outremer, DFC, IV-167.
120 AG, CTG, 14-tablette 15.
160 AN, Outremer, DFC, IV-161.
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163 AN, Outremer, DFC, IV-169.
164 Ibid., IV-252.
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166 Ibid., IV-163.
167 AN, Col., $C^{11}A$, Vol. 126, f. 77.
168 AN, Outremer, DFC, IV-178.
190 BG, Atlas de Masse, MS 131d (in folio).
194 Ibid.
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206 AN, Outremer, DFC, IV-223.
207 Ibid., IV-224.
209 AN, Col., $C^{11}A$, Vol. 126, f. 79v.
212 Ibid., f. 227.
213 Ibid.
221 Ibid., f. 139.
223 AG, CTG, 14-1-22.
224 AN, Outremer, DFC, IV-197c.
225 Ibid., IV-199c.
228 Ibid., IV-156.
229 Ibid., IV-212.
231 Ibid., IV-155.
232 Ibid., IV-179.
233 Ibid., IV-187.
234 FLNHP, L 1745-1b.
235 AG, CTG, 15-3-1.
236 FLNHP, L 1745-32.
237 AN, Marine, B^4 -- 285.
239 BN, CP, Service Hydrographique, 131-10-11.
240 Ibid.
241 Ibid.
242 Paris. Bibliothèque de l'Arsenal, Vol. 6432, 19a.
245 AN, Col., $C^{11}A$, Vol. 126, f. 245.
246 AN, Outremer, DFC, IV-46c.
247 AN, Col., F^3, ff. 290-90.
249 BG, Atlas 126, No. 93, n.d.
251 PAC, MG 18, K2, "Traité de Fortifications, Chaussegros de Léry, 1714, p. 59.
252 BG, Atlas de Masse, MS 131d (in folio).

ARROW (FLECHE). A defensive work in front of a salient angle in the glacis, consisting of two parapets, each ca. 7 m long, forming a salient angle; may be connected to the covered way by a protected passage or *caponière* (q.v.). (Smith, Military Dictionary; Muller, Fortifications, pp 43-45.)

ABBATIS. A barrier consisting of whole trees felled and laid out with their branches towards an enemy; preferably the branches of different trees are intertwined. The tree trunks serve as breastworks. Used around redoubts, retrenchments or on the edge of a wood in skirmishes. (Fig. 237; Smith, Military Dictionary.)

APPROACHES. General term used to refer to siege-works being pushed forward against a place: comprises trenches, parallels, saps, galleries and mines. Also, an alternative for "attack." (Smith, Military Dictionary.)

BANQUETTE. Firing step at the base of the parapet on the rampart or covered way; usually of earth, 3 *pieds* high and 3 *pieds* wide, with a slope down to the terreplein level, but exceptionally a short step or series of steps in masonry, as at Brouage. (Fig. 132.)

BARBETTE. Platform for gunnery, such that guns can fire over parapet without need of embrasures. A gun is then said to be firing *en barbette*.

BARBICAN. An outer defence used in medieval fortifications in front of a gateway or guarding a bridge; consists essentially of a screen wall, often semicircular in plan, provided with archery slits. May be thought of as the precursor of *demi-lunes* and even of bastions.

BARRIERE. Fence or gate of vertical bars affixed to horizontal cross-pieces and reinforced with a diagonal; used to seal off passageways, sorties, ends of retrenchments. (Smith, Military Dictionary.)

BASCULE. Counterpoised gate, usually serving as a drawbridge as it moves from a vertical (closed) to a horizontal (open) position. Counterweight may be overhead, in which case large swipe-beams extend outwards for the length of the movable part of the bridge, to which they are attached by chains, or below ground, in which case they sink into a pit or chamber beneath the gate. (Figs. 1, 166, 167, 194, 195, 209.)

BASTION. Defensive work, consisting of two flanks and two faces, projecting forward of the fortified area and usually open at the rear gorge. (Figs. 7, 8, 25, 36, 37, 40, 41.)

BASTION, FLAT. A work projecting midway along a curtain which is too long to be covered by regular bastions at each end of the curtain. (Fig. 47.)

BASTION, HALF- (DEMI-BASTION). A work consisting of only one face, flank and demi-gorge; often used as part of a horn-work (q.v.). (Fig. 18.)

BASTION, DOUBLE. A bastion raised on the plane of another, but 4-5.5 m higher, in the manner of a cavalier (q.v.).

BASTION TENAILLE (FORKED BULWARK). Bastion in which space did not permit faces to extend fully and intersect to form normal flanked angle; instead, reentrant is formed, presenting a V-shaped front to country. (Fig. 21.)

BATARDEAU. Masonry wall built across the end of a ditch to maintain water level, usually controlling it by means of a sluice. (Figs. 97, 166, 167.)

BATTERY. Raised position for mounting heavy guns; may be applied generally to defensive positions as an alternative term to flanks of bastions or as a descriptive term for the principal function of detached forts, e.g. Island Battery, Royal Battery. Often used specifically to refer to besiegers' gun emplacements.

BERM. Level space ca. 1.5 m wide between rampart and ditch to prevent rubble from rampart falling into ditch.

BLINDS, BLINDAGES. Thick wooden planks laid across the tops of trenches to support heavier protective material. (A. Swall, Method of Fortification.)

BOMBARD. Short, thick piece of ordnance developed in 15th century; would fire a large missile weighing up to 300 lbs. in a high trajectory over short distances.

BONNET. Small additional defensive work consisting of two faces like a ravelin (q.v.) with low, wide parapet; may be placed in front of salients on the main *enceinte* or on the glacis (similar in form and function to arrows and counterguards). (Smith, Military Dictionary.)

BONNET A PRETRE (PRIESTS' CAP). Outwork consisting of three salient and two re-entrant angles: a variant of a horn-work, but with a *tenaillé* instead of a bastioned front. (Smith, Military Dictionary.)

BOULEVARD. Alternatives: *bolluardo* (Italian); *bollwerk* (German); *bulwark* (English). Precursor of the bastion; wide, raised platform, usually of earth, set at base of existing medieval *enceintes* as artillery emplacement, or raised by besiegers to defend siege lines.

BRAIE. Outer *enceinte* used in medieval fortifications, consisting of wooden palisade or low masonry wall on the counterscarp of the ditch. (Viollet-le-Duc, Military Architecture.)

BRISURE. A line "from four to five fathom" changing the alignment of the curtain in cases where the adjacent bastion has an *orillon* (q.v.) protecting a curved flank. (Figs. 16, 40-43.)

CAISSON. Iron-bound chest filled with gunpowder and buried in the ground before an attack; a primitive land-mine. (Smith, Military Dictionary.) Also a charge fired to cave in an enemy mine gallery.

CAMOUFLET. "A kind of stinking combustibles" used to smoke miners out of a gallery. (Smith, Military Dictionary.) Also a charge fixed to cave in an enemy mine gallery.

CAPITAL LINE. Theoretical line bisecting a bastion from the flanked angle to the point at which the prolongation of the curtains would intersect.

CAPONIERE. Passage from one defensive work to another, 3-4 m wide and with a parapet on each side; usually there is a short glacis beyond the parapet (Smith, Military Dictionary). In late 18th- and 19th-century fortification, a low, roofed, masonry gallery in ditch, perpendicular to *enceinte*, providing flanking fire; in perpendicular system which replaced bastioned system, *caponières* replaced bastions.

CARCASSE. Explosive projectile: large canister loaded with three or four grenades, scrap-metal etc. and fired in the air to explode overhead (primitive form of shrapnel). (Swall, Method of Fortification.)

CASEMATE. (From Italian *casa matta*, literally, "madhouse." Whether it was thought madness to be in one or to attempt to attack one is open to conjecture.) Originally detached structures in the ditch, casemates were at an early date in the development of bastions incorporated into the flanks, where they took the form of vaulted chambers with embrasures for artillery to fire along the ditch. They were a characteristic feature of Italian fortifications in the 16th century and of other schools that followed the Italian early in the 17th century but then became less frequently used. Vauban reverted to a form of casemated fire in his *tours bastionnées* towards the end of his career. By the 18th century the term was generally applied to any form of chamber buried in the ramparts regardless of whether there were artillery openings or not. (Figs. 8, 10, 25, 36.)

CASERNES. Troop quarters; barracks.

CAVALIER. Artillery battery raised up on the ramparts of the main defences to give additional fire-power and command over the surrounding country. (Figs. 95-97.)

CAVALIER DE TRANCHEE. Form of parapet raised at edge of besiegers' trench or sap permitting troops to counter fire from parapet of besieged place in comparative safety; invented by Vauban.

CHANDELIER. Earth-filled wooden sections of movable parapet, about 30 cm high, used as protection from enemy fire when pushing forward trenches.

CHEMIN DE RONDE. Walkway around ramparts. In medieval fortifications, it was located behind the crenellated parapet or over machicolations; in the 16th and early 17th centuries one was often placed on the escarp below the parapet, but its vulnerability to artillery fire led to its abandonment in the latter half of the 17th century. Where space restrictions permitted only a very narrow parapet, the walkway was also referred to as a *chemin de ronde* in 18th- and 19th-century fortifications. (Figs. 8, 26, 33, 252 [inset 10])

CHEVAUX DE FRISE (FRIESLAND HORSES). Large timbers 3-3.5 m long, square or hexagonal in cross-section, with iron-tipped wooden stakes projecting from each facet at close intervals; used as barriers to resist troop advances and as a means of blocking a breach in preparation for an assault. (Smith, Military Dictionary.)

CIRCUMVALLATION, LINES OF. Ditch and parapet surrounding a siege camp to guard against attack by a relief force, and also to limit desertions. (Figs. 31, 32; A. Swall, Method of Fortification.)

CORDON. Semicircular belt-course of dressed stone set between top of escarp and base of parapet; originally designed as a means of hindering assault by escalade. (Figs. 45, 144, 252.)

COUNTERFORTS. Pillars or buttresses spaced 4.5-6 m apart to reinforce escarp walls; may also serve as support for rampart surface and *chemin-de-ronde*. In late medieval contexts, sometimes used on the outer surface of walls (e.g. Southampton, Bonaguil) but with the evolution of bastioned defences, were afterwards used exclusively on the inside of escarps. (Figs. 5, 6.)

COUNTERGUARD (CONTREGARDE). Defensive work consisting of two faces; placed in ditch in front of bastion to serve as additional protection. (See also *Bonnet*.) Recommended by Pagan as a means of strengthening bastions and prolonging the defence; counterguards were used by Vauban in a modified form as detached bastions in their own right. (Figs. 37, 54, 55.)

COUNTERMINES. Frequently built into the defences at vulnerable places in readiness for an attack; alternatively, they could be dug towards an enemy mine or position once it had been detected.

COUNTERSCARP. Wall limiting the ditch opposite the escarp; retains the covered way and glacis. (Figs. 44, 132, 217.)

COUNTERVALLATION, LINE OF. Ditch and parapet, often with salients, surrounding and facing towards a besieged place to defend besiegers against sorties by besieged garrison. (Figs. 31, 32.)

COVERED WAY (CHEMIN COUVERT). Walkway level with top of counterscarp; the glacis serves as a parapet, being retained by a revetment wall with a banquette at base. (Figs. 44, 60, 132, 217, 218.)

COUPURE. Passage 3.5-4.5 m wide cut through re-entrant angle of covered way and glacis to enable besieged garrison to make sorties or sallies. (Smith, Military Dictionary.)

CREMAILLE, CREMAILLERE. Trace of a rampart or parapet zigzagged or resembling saw-teeth so that the many re-entrants permit flanking fire without using bastions. Frequently employed along cliff edge or shoreline where space restrictions would not allow regular bastioned *enceinte*, as at Mont Dauphin, Blaye, Antibes, Quebec. (Figs. 243, 244.)

CROWN-WORK (OUVRAGE A COURONNE). Outwork consisting of a central bastion flanked on each side by a demi-bastion; regarded as an expensive and therefore rarely constructed form of defence. Sometimes used in conjunction with horn-works (q.v.), being placed in front of them, as at Philippsburg. (Figs. 19, 22, 58; Swall, Method of Fortification; Smith, Military Dictionary.)

CUNETTE (less commonly, CUVETTE). Small ditch in centre of main ditch; dug down to water level wherever possible as a way of hindering miners approaching the escarp, also as an additional obstacle to direct assault. Good examples may be seen around the citadels of Lille and St. Martin-de-Ré.

CURTAIN (COURTINE). Length of straight wall between two bastions; provided with terreplein, banquette and parapet and sometimes embrasures to permit forward as opposed to flanking fire.

DEFENCE, LINE OF (RAZANT). Theoretical line representing the flight of a musketball from the parapet of a flank to sweep along the face of the adjacent bastions; expressed another way, it is the prolongation of the face of one bastion to the flank of the next. The distance is measured from the flanked angle to the adjacent re-entrant angle, and should not exceed effective musket-range (i.e. 150 *toises*).

DEFENCE, LINE OF (FICHANT). Prolongation of the face of a bastion which intersects the curtain short of the re-entrant angle of the adjacent bastion; fire from the flank of the latter bastion will thus strike rather than sweep along the face it is defending. (Fig. 16.)

DEMI-LUNE. Defensive work placed in the ditch in front of a bastion or curtain: location and terminology varied from 16th-18th centuries; usage differs in English and French and hence has led to some confusion with the term "ravelin."

Prior to the development of bastioned fortifications, barbicans (q.v.) in front of the main walls frequently guarded entrances, providing additional defence in depth. With the introduction of artillery, boulevards (q.v.) were frequently used in front and at the base of existing *enceintes* to provide flanking fire against an assault. It is clear that both barbicans and boulevards contributed to the development of the bastioned system; in particular, the barbican seems to have served as inspiration for a detached work in the ditch, as the D-shaped structures placed before the entrance and corner towers of Salses (ca. 1600) would suggest (Fig. 4).

Triangular works -- in effect, based on a detached bastion trace -- placed in the ditch before the curtain and covered by flanking fire from the main *enceinte*, first appeared in early 16th-century fortifications; supposedly, they caused an enemy to reveal his presence before he could begin his attack on the place itself, hence the term *revellino* or *rivellino*. With the influx of Italian engineers and fortification concepts into France during the 16th century, the French adaptation ravelin came into general use. In the treatise of Errard de Bar-le-Duc, the term is applied to works placed in front of a medieval *enceinte* as an alternative to bastions, or to works placed in the ditch between two bastions in the case of a newly constructed, bastioned *enceinte*. Errard uses the term *demi-lune* to refer to an enlarged section of the covered way at the salients: in effect, a form of boulevard or *place d'armes*.

A similar distinction is made by de Ville, the ravelins always being placed in front of the curtain, but *demi-lunes*, located on the covered way, may be either at salient angles or in front of the curtain; in addition, a small ravelin between the demi-bastions of a horn-work is referred to as a *demi-lune*.

Following the Dutch War of Independence, during which the Dutch, frequently unable to afford expensive bastioned *enceintes*, relied on the defence in depth provided by extended series of outworks, the Dutch application of the term "half-moon" (*halve maan*) to a semicircular or ravelin-shaped work in front of the curtain came into general use. Vauban's design of a large detached work, usually with short flanks in addition to two long faces, was always referred to as a *demi-lune* and the term ravelin gradually dropped out of use in France. While "halfe Moones" were referred to in 17th-century English contexts (Ward, Animadversions of Warre, 1639), the term "ravelin" was retained later and is current throughout 18th- to 19th-century English texts. (Figs. 17, 94, 100.)

DONJON. Keep or tower: place of last retreat and resistance within a larger fortification.

ECHAUGETTE. Watch-tower (medieval). General term for sentry-box or look-out post, either attached to ramparts or free-standing. See also *Guérite*.

EMBRASURE. Opening in parapet, usually flared, through which cannon are fired. (Figs. 45, 144, 145, 251, 252.)

ENCEINTE. Defensive perimeter of a place (from Fr. *ceinture*, a belt).

ENFILADE (verb, tr.). To be able to rake the whole length of a line of fortifications e.g. rampart, covered way or ditch, or a line of troops, with fire.

EPAULE (SHOULDER). Corner of bastion where face and flank meet. Hence: shoulder angle or angle of the shoulder.

EPAULEMENT. Elongated breastwork of temporary nature, constructed out of gabions (q.v.) or fascines (q.v.) and earth to provide shelter for troop movement. Frequently refers to a work thrown up to defend a flank. (Smith, Military Dictionary.)

ESPLANADE. Place between citadel and town, kept free of buildings and other obstacles. (Fig. 43; Swall, Method of Fortification.)

FACE. Wall of bastion closest to country.

FASCINE. Bundle of brushwood, 20-60 cm in diameter and 1.5-2 m long, bound tightly together; widespread application in both defence and attack to fill in breaches, ditches, provide temporary cover, etc.

FAUSSE-BRAIE. Small rampart with parapet and banquette, located in front of base of main *enceinte* in ditch or on top of berm; used for additional musketry defence when enemy had advanced so close as to be beneath maximum depression of fire possible from main parapet. Also favoured by de Ville and others because débris from escarp would be contained rather than spreading out and filling up ditch. *Fausse-braies* were regarded as impractical by Pagan and Vauban, and fell out of use during latter half of 17th century; however, Vauban introduced a modification which he referred to as a tenaille (q.v.). (Fig. 33; Muller, Fortifications.)

FER A CHEVAL (HORSESHOE). Curved or semicircular work with parapet, usually placed so as to defend a gateway; also referred to as a *pâté* by Swall. (Figs. 21, 160-165.)

FLANK. Part of the escarp of a bastion connecting curtain to face; provides defensive fire to the face of the next bastion and defends curtain, ditch and outworks.

FLANK, TO. To command a defence system completely so that there is no dead ground.

FLANKED ANGLE. Angle formed by the intersection of the two faces of a bastion; the angle closest to the country.

FOUGASSE, Var. FOUGADE, FOUDAGE. Small mine buried in glacis or bottom of ditch, fired at moment of an enemy's approach.

FRAISES. Sharpened stakes ca. 2 m long projecting out from an earth rampart towards the country as a means of thwarting an assault. (Swall, Method of Fortification.)

FRONT (OF FORTIFICATIONS). Side of polygon on which trace is based; distance from flanked angle of one bastion to the next.

GABIONS. Wicker baskets ca. 1.0 m in diameter, filled with earth to give cover on parapets, batteries, trenches etc. (precursor of sandbags).

GENOUILLERE. Solid portion of parapet beneath an embrasure, protecting gunners and gun-carriages fron enemy fire. (Fig 144.)

GLACIS. Parapet of the covered way "which loses itself insensibly in the field," i.e. an exposed earth slope serving as an outer *enceinte* and screen for the main defences. (Fig. 132; Swall, Method of Fortification.)

GORGE. Entrance to a bastion from the interior of the place; the distance between the left and right re-entrant angles where the flanks of the bastion join the curtains. Usually open, may be closed entirely or in part with a barracks, arsenal or other military building. Bastion may be isolated from the interior of the place by an already existing town wall; rarely with a continuous curtain closing off the gorge in new work -- Mont Louis is an important exception. (Fig. 43.)

GUERITE. Look-out or sentry-box, round or polygonal in plan, usually in stone, cantilevered over ditch at salient angles of bastions to watch for enemy approaches in ditch. *Echaugette* is sometimes used as an alternative. (Figs. 155, 156.)

HERSE (PORTCULLIS). Lattice-work barrier held by cable around a winch and lowered in time of danger to block a gateway.

HORN-WORK (OUVRAGE A CORNE). Outwork consisting of front with two demi-bastions; an elongated tenaille. (Fig. 18, 21, 48.)

LODGEMENT. Makeshift defensive work thrown up at a critical point using whatever materials are available; usually applied to a position established by besiegers who have succeeded in driving the defence back and who wish to guard against counter-attack. (Smith, Military Dictionary.)

LUNETTES. Additional detached works placed on both sides of ravelin or *demi-lune;* also, small ravelins opposite outer *places d'armes* when two ditches are used. (Smith, Military Dictionary.)

MACHICOULIS, MACHICOLATION. Open space in floor of corbelled-out gallery overlooking base of rampart, also over gate; primarily found on 14th- to 16th-century fortifications prior to evolution of bastioned works, but also used in special circumstances such as coastal defence-towers where lightly armed attacks only were to be expected, 17th-18th century.

MEURTRIERES. Arrow-slits introduced in medieval defences in 12th century; term later applied to loopholes for firearms.

MERLON. Solid section of parapet between two embrasures. (Fig. 144.)

MINE. Underground passage dug beneath wall or rampart to bring it down; from end of 15th century, gunpowder was used to achieve this. (Prior to introduction of explosives, foundations were shored up with timbers which were then ignited by retreating miners.) Passage is referred to as the gallery; the combustibles or explosives were placed in chambers. First recorded use of successful exploding mine was at Naples in 1503. (Smith, Military Dictionary.)

MOINEAU. Small masonry work attached to base of rampart to provide defensive fire in ditch; 15th-century precursor of casemates and *caponières*. (Fig. 6.)

ORGUES (Organ pipes). Stout wooden beams, shod with iron, suspended individually over gateway by ropes; de Ville recommends them instead of portcullis because they are less readily broken up by petards (q.v.). Figs. 35, 194; de Ville, Fortifications.)

ORILLON. Defensive element of bastion, located at shoulder; acts as screen for artillery in the flank. Originating with early Italian bastioned system, late 15th-early 16th century, *orillons* remained an essential element of bastions throughout 17th century; in 18th-century treatises, they were still favourably regarded although in fact rarely built. When incorporated in fortifications by Vauban, *orillons* invariably accompanied a retired, curving flank and a slight break (*brisure*) in the alignment of the curtain. (Figs. 7, 10, 40, 41, 45, 47, 49.)

PALISADES. Wooden stakes, ca. 2.0 m high, set into the defences of a fortification in front of curtains, ramparts and, most frequently, on covered way behind revetment of glacis.

PARALLELS. Siege trenches dug parallel to the line of the *enceinte* under attack. Usually three parallels were established during a classic *siège en règle* as practiced by Vauban; the first was ca. 550 m away from the covered way, the third was at the foot of the glacis. (Figs. 38, 58, 59.)

PARAPET. Raised mass of earth on top of rampart behind which soldiers can stand and fire in relative safety; artillery may also be located behind parapet. Exterior of parapet may be sloped, retained by carefully stacked blocks of turf; or may be vertical, in which case it is retained by a masonry revetment. At rear, it is retained by vertical or near-vertical masonry revetment against which soldiers may lean when firing; height at front so as to permit plunging fire, usually aligned on covered way or glacis. (Figs. 80, 83, 144, 251, 252.)

PATE. Earthwork of oval or horseshoe shape with parapet but no other defences; usually erected in marshy ground to cover gate into a place (Duane, Military Dictionary). Also, late medieval form of boulevard around base of tower: cf. "Pâté aux Anglais" at Provins (Toy, History of Fortifications).

PETARD. Explosive device in form of bucket or bell; filled with powder and closed off with stout plank which is then affixed to a gate or door. (Fig. 34; de Ville, Fortifications.)

PLACE D'ARMES. Open area for troop assembly; on covered way, salient area near bastion providing flanking fire along glacis and as an assembly point prior to a sortie to attack besiegers.

POSTERN. Vaulted passageway in rampart, providing communication across ditch to outworks; usually located in middle of curtain to lead to *demi-lune*. (Belidor, Science des Ingénieurs.)

QUEUE D'ARONDE (D'IRONDE). Outwork like horn-work, but narrower at gorge that at front. (Lit. swallow's tail.)

RAMPART. Massive bank of earth thrown up *(rempiré)* around a place as defence behind ditch; usually 5.5-6 m high, 18-22 m thick, revetted at front with masonry escarp, sometimes with rear revetment, but usually sloped; surmounted by parapet.

RAVELIN. See *Demi-lune*.

REDAN. Triangular projection from a line of fortification (frequently on a line of circumvallation). (Muller, Fortifications.)

REDOUBT. Small, square fort, usually defended only in front; frequently used as part of defences in siege lines; also as detached works beyond glacis. (Swall, Method of Fortification.)

REDUIT. Retrenched position within another defensive work, to retire to in case of surprise attack; Vauban's *demi-lunes* were frequently retrenched in this manner. (Figs. 17, 38.)

RICOCHET. Firing of guns with reduced charge and low trajectory so that shot just passes over parapet and then skips along a rampart or covered way in line of fire. Invention generally accredited to Vauban, although de Ville had earlier pointed out the possibilities of using skip-shots against advancing troops.

SALLY, SORTIE. Attack on besiegers by garrison from within besieged place.

SAP. Form of trench, often pushed forward up glacis to covered way; earth removed is used as cover to right and left, top may be screened over.

SAUCISSE. Fuse for mines, bomb-chests, etc. made out of long pieces of cloth rolled into a tube, dipped in pitch and filled with black powder.

TENAILLE (LITERALLY, "PINCERS"). A tenaille front *(front tenaillé)* was simply a front of fortification, with re-entering angle in front; may be flanked at each extremity. As described by Errard de Bar-le-Duc, a tenaille consisted of two ravelins joined together by a curtain. Late 17th-century and subsequent usage was based upon Vauban's concept of low work in ditch in front of curtain; various traces were applied, all consisting of rampart-like work with parapet to provide additional musketry fire. (Figs. 38, 39, 55; Muller, Fortifications.)

TERREPLEIN. Level surface of rampart behind parapet; also any level surface in defensive work.

TOUR BASTIONNEE (TOWER-BASTION). Storeyed masonry tower, casemated for artillery; as applied by Vauban, placed at angles of polygonal *enceinte* instead of regular bastions, with detached bastions or counterguards in front where terrain permitted. (Fig. 52-56.)

TRACE. Outline of a fortification in plan.

TRAVERSE. Earthwork in form of parapet, usually placed on covered way near *places d'armes* and opposite salients to prevent enfilade and to provide cover for troops defending covered way during assault; after invention of ricochet fire by Vauban, frequently used on ramparts also. (Figs. 60, 218.)

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The French defended their North American territories with isolated forts at strategic sites in the wilderness and with bastioned masonry walls around the three towns important enough to warrant such fortifications: Montreal, Quebec and Louisbourg. Documentary, architectural and archaeological evidence reveals to what extent the French, then predominant in military engineering, applied long-established Old World methods at Louisbourg and to what extent they adapted to the different physical and military environment of the New World. Twice besieged, Louisbourg was twice taken. Yet in both sieges it held out, unaided, for more than six weeks after the enemy had landed. More could not have been asked.

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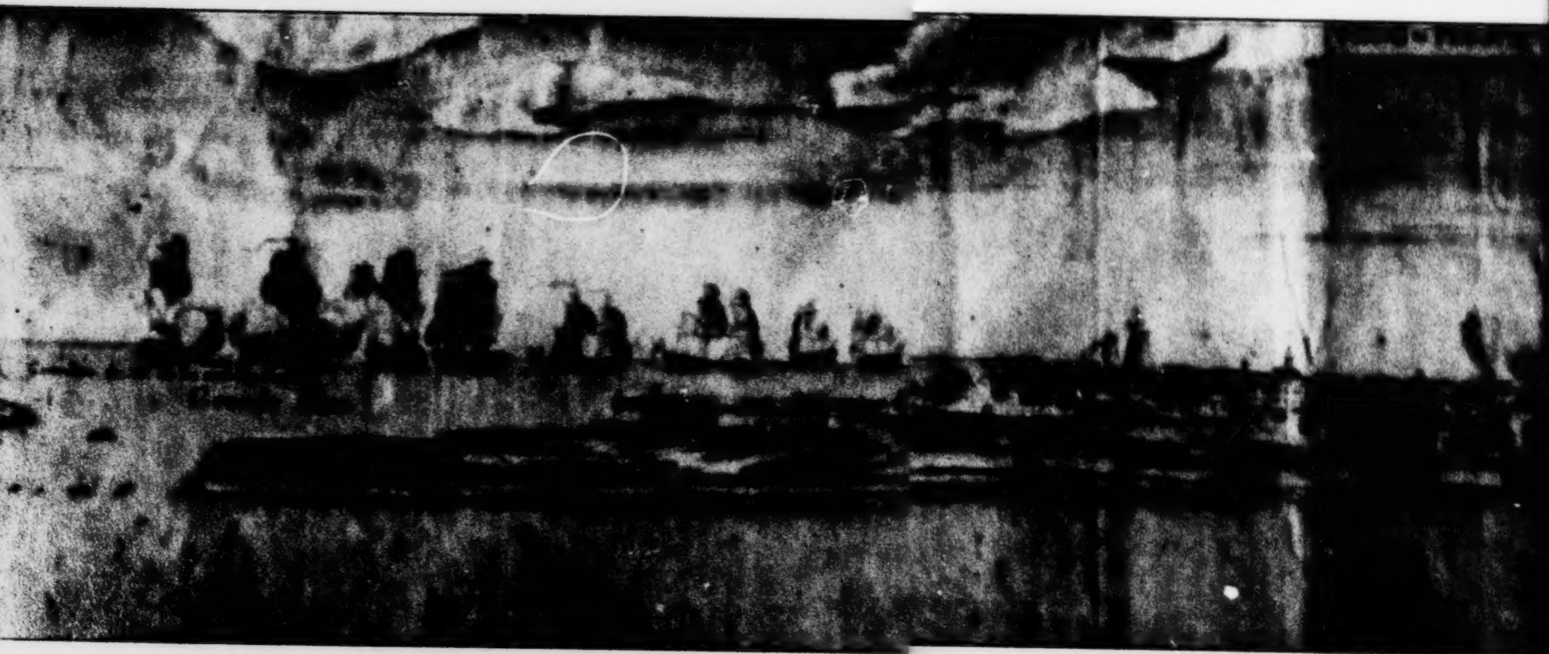

Canada

Volume

2

"An appearance of strength"
The Fortifications of Louisbourg

Volume Two

Bruce W. Fry

Parks Canada Parcs Canada

Cover: Louisbourg under siege, 1745. (Bibliothèque Nationale, Paris.)

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Volume Two

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Architecture and History

National Historic Parks and Sites Branch
Parks Canada
Environment Canada
1984

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Illustrations

1 **Montmédy (Meuse).** The outer drawbridge, built in the 16th century. The small door to the right has its own drawbridge, operated by a simple overhead beam. (Photo by author.)

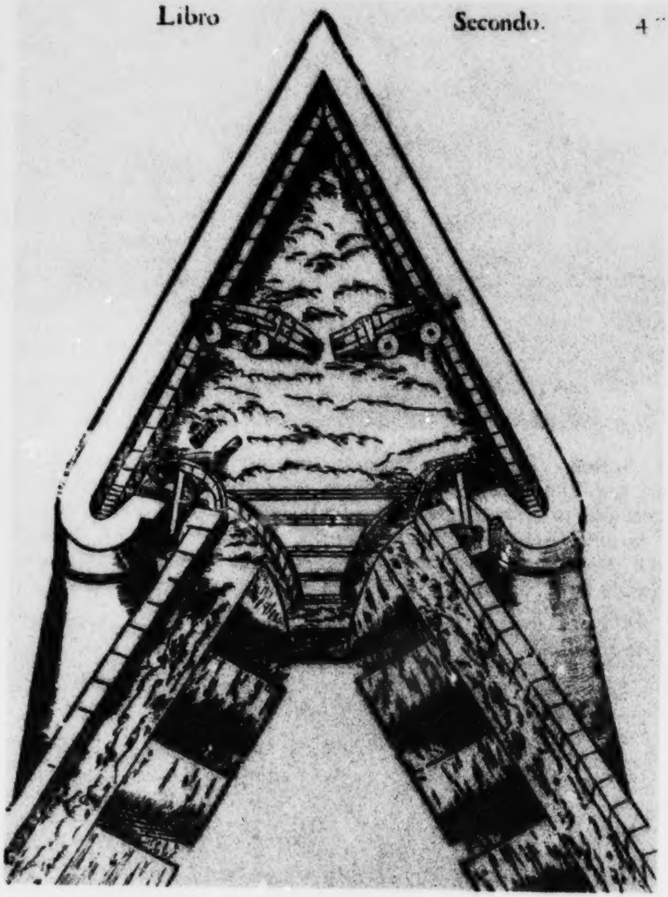
2 **Fougères (Ille-et-Vilaine).** *Fer-à-cheval* gun tower (15th cent.) added to medieval *enceinte*. Note the machicolations on the curtains and the arrow-slits modified for firearms in the square tower. (Photo by author.)

3 **Salses (Pyrénées – Orientales).** General view of the castle from across the glacis, accentuating the sunken nature of the defences. Note the curved revetment of the parapet on the curtain. (Photo by author.)

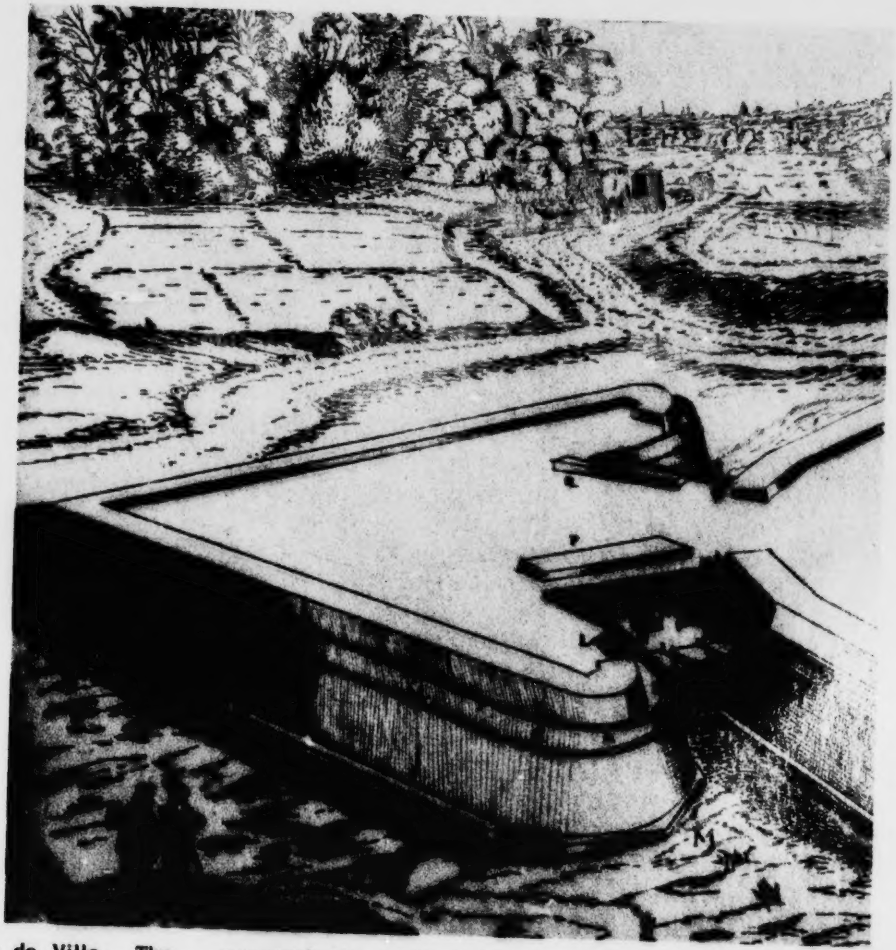
4 **Salses.** The main entrance, between the circular towers on the *enceinte*, is accessible only by passing through a gateway in a small, detached work (centre left) and then into a larger, D-shaped detached work. These two works, both in the ditch, mark the transition from barbican to *demi-lune*. (Photo by author.)

5 **Bonaguil (Lot-et-Garonne).** General view of the late 15th-century castle. Note rectangular slits for artillery near the bases of the towers. To the right, supported by buttresses or counterforts, is a wide terrace used for the deployment of artillery. (Photo by author.)

6 Bonaguil. The ditch defences. Artillery fire could be trained on an enemy in the ditch from concealed positions in the bridge pier (centre left) and the *moineau* (right foreground). (Photo by author.)



7 Early Italian form of bastion. Note the very restricted, concealed flanks with casemates for artillery hidden by the rounded *orillons*. (Girolamo Maggi and Iacomo Castriotto, *Fortificazione delle Città* [Venice, 1583].)

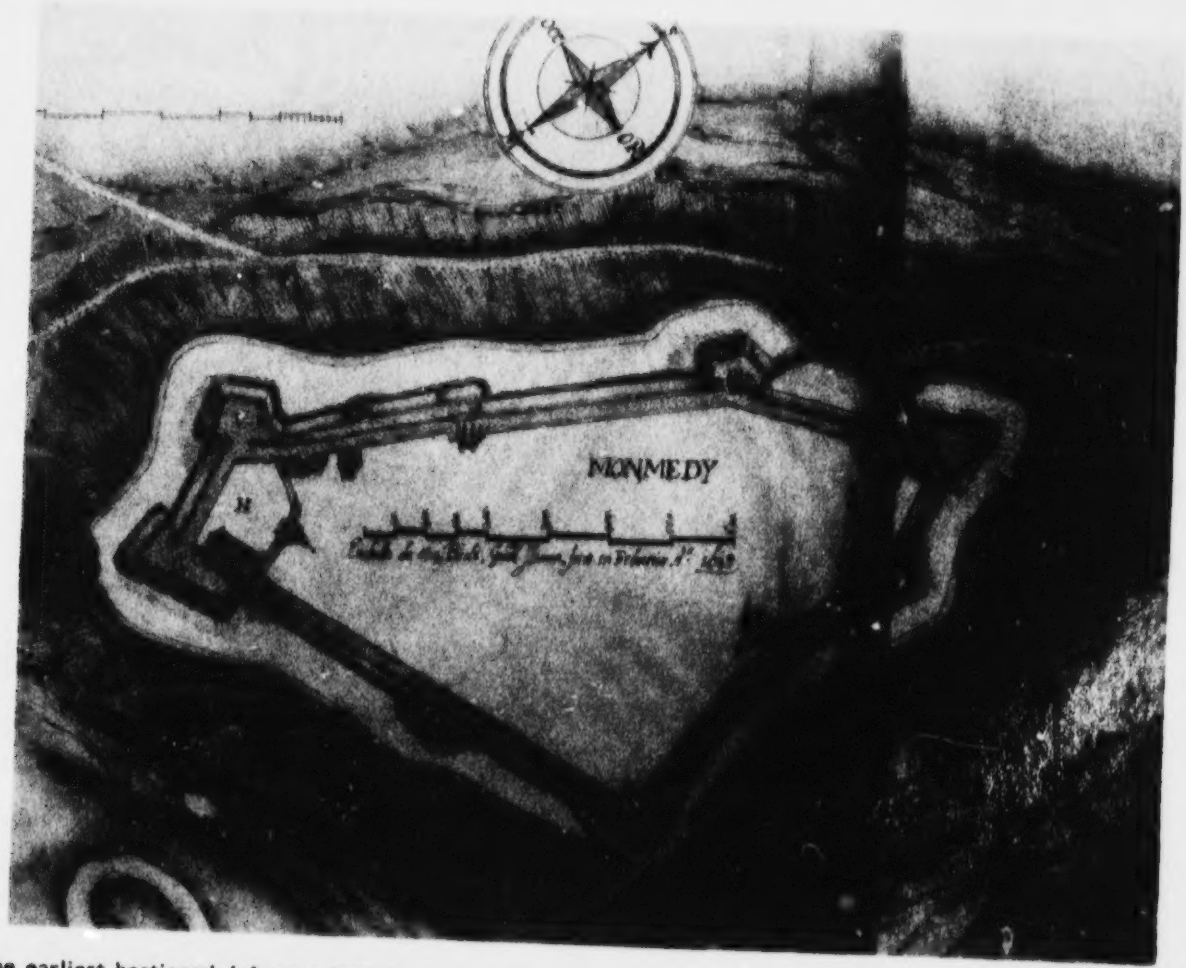


8 Early form of bastion as illustrated by de Ville. The Italian influence is evident in the slender, pointed form and the deeply recessed, casemated flanks. A *chemin de ronde* surrounds the work at the base of the parapet. (Antoine de Ville, *Les fortifications, attaques & défenses des places....* [Lyon, 1628], p. 77.)

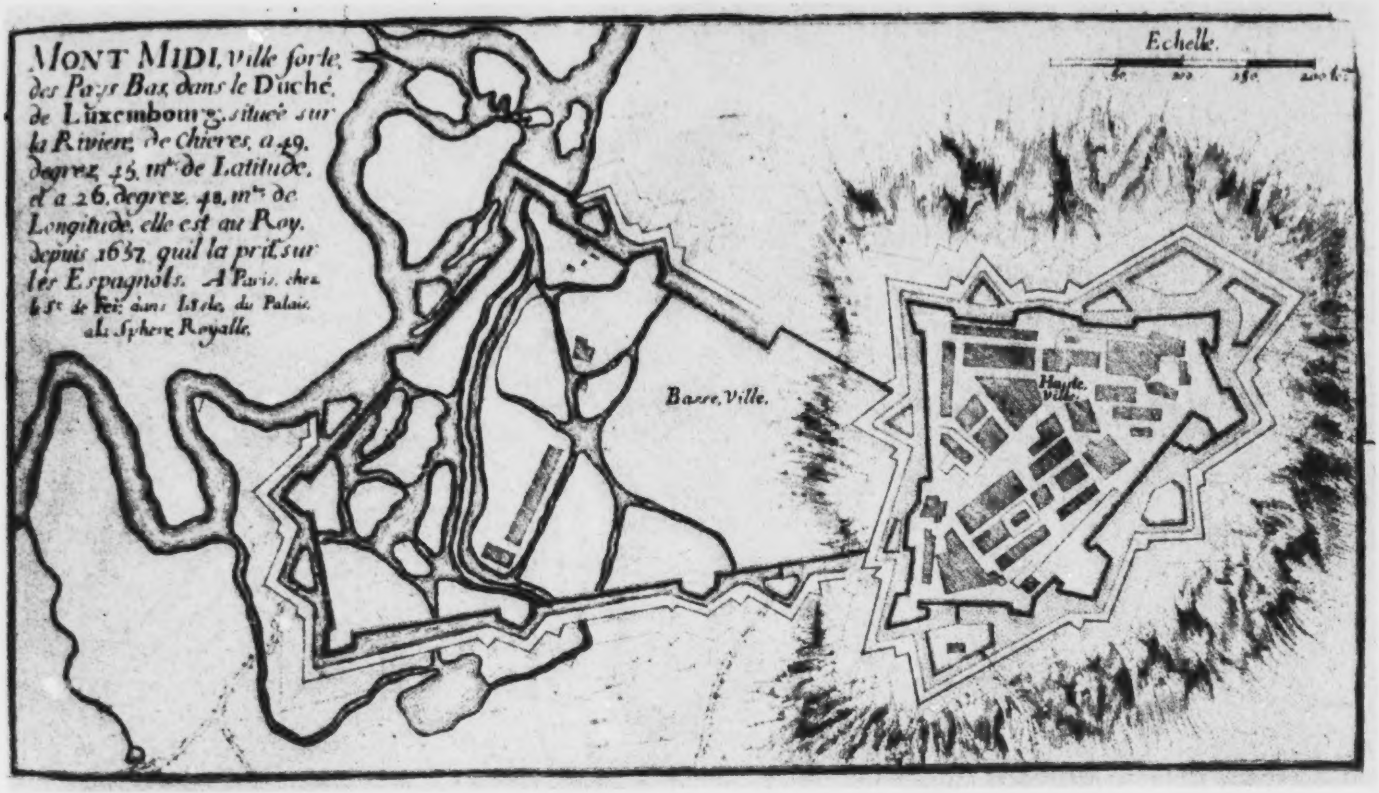
9 Candia (Crete). The island stronghold of the Venetian Republic in the Mediterranean, under siege by the Turks, 1667. The defences, designed in the late 16th century by Sanmicheli, are characterized by irregular bastions, with elongated *orillons* concealing casemated flanks. The protracted siege (1648-69) excited considerable interest and the experiences of various relief forces from several countries influenced military theory. The effectiveness of the casemated artillery in repelling mass onslaughts encouraged development of powerful flanks in bastioned systems, while the use of parallel trenches, almost as close together as plough furrows (on right, also lower left), supposedly inspired Vauban's method of attack. The siege was noteworthy, too, for the amount of mining and countermining that went on. Note the two lines of retrenchment within the walls of the town: one to contain an assault after the bastions at the northwest front had been breached, the other to isolate the northeast corner of the town once the rest had been overrun. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)

La Ville de Candie
Mer de Candie

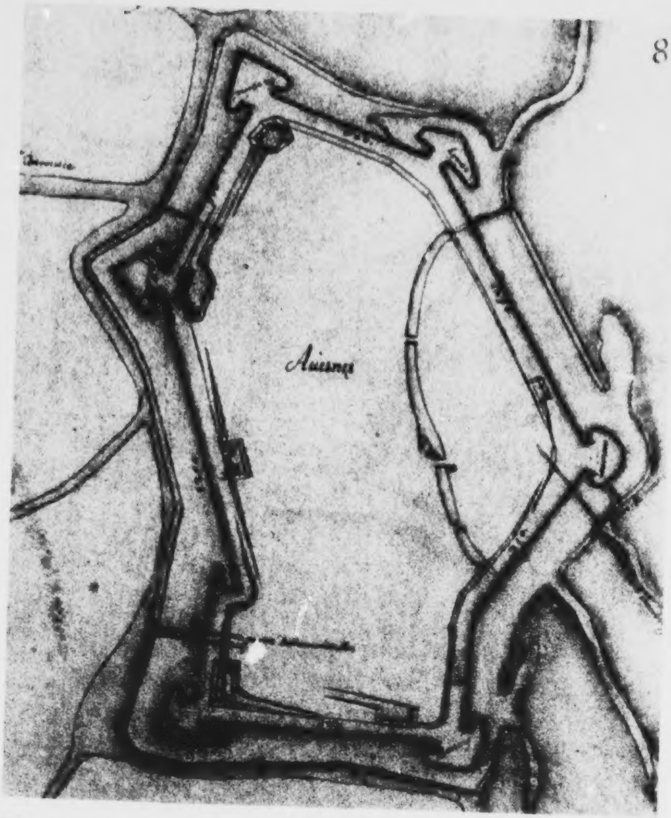
10 Siege of Candia. Detail. The attack on the northwest front toward the final stages of the siege. The network of Turkish trenches has reached the crest of the glacis and begun to advance across the ditch. The damaged bastions have been strongly retrenched in anticipation of an assault. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)



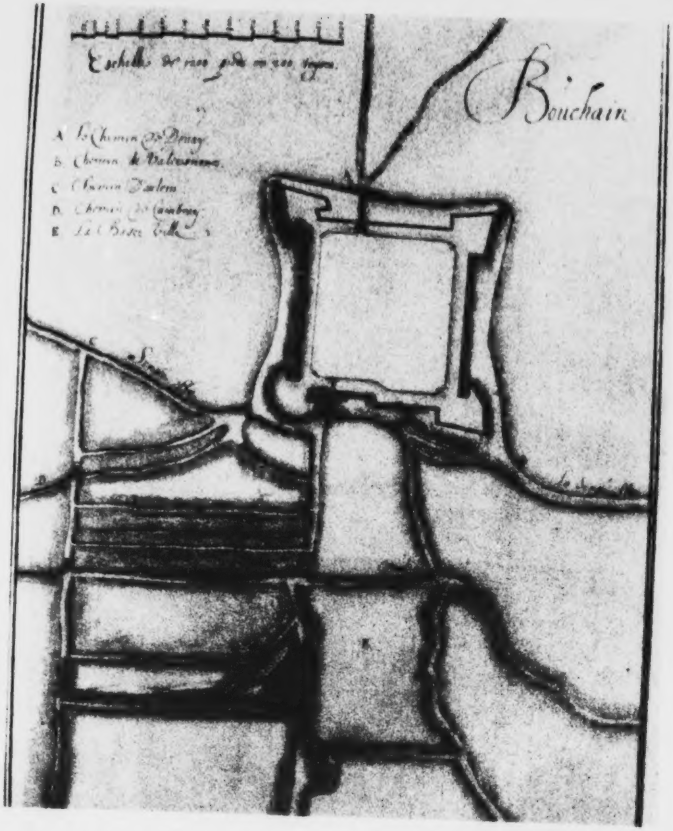
11 Montmédy. The earliest bastioned defences, built in the 16th century, when the town was part of the Spanish empire. The bastions are referred to on the accompanying legend as "boullevarts." K: *orillon* providing flanking fire. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)


MONT MIDI, ville forte,
des Pays Bas, dans le Duché,
de Luxembourg, situeé sur
la Riviere de Chieres, a 49.
degrez 45. m.tes de Latitude,
et a 26. degrez 48. m.tes de
Longitude, elle est au Roy,
depuis 1657. quil la pris sur
les Espagnols. A Paris, chez
le Sr. de Fer, dans L'Isle du Palais
a la Sphere Royalle.
Echelle.
50. 100 150. 200 t.
Basse Ville.
Haute Ville.

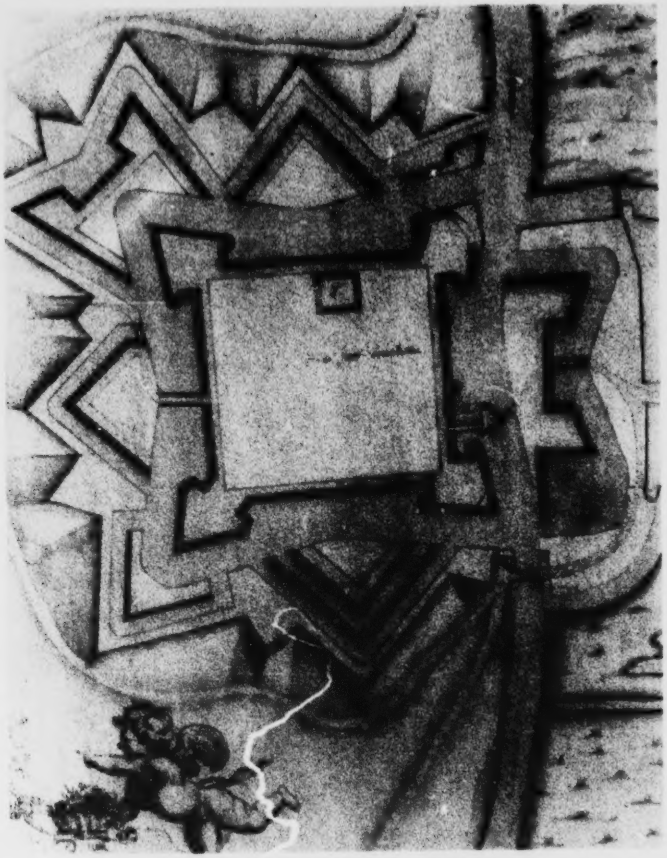
12 **Montmédy.** Taken by the French in a costly siege in 1657, the upper town was re-fortified by Vauban, who maintained the existing defences wherever possible. Plan shows the modified defences and the new "enceinte" of the lower town. (De Fer, *Force de l'Europe: Introduction à la fortification* [Paris, 1695], p. 92.)



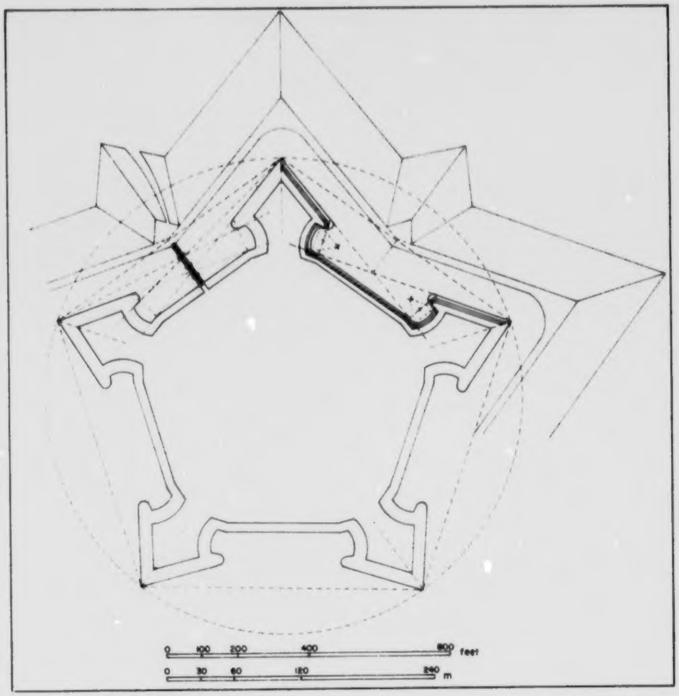
13 **Avesnes-sur-Helpe (Nord).** An early plan of defences using irregular Italianate bastions of 16th-century style. Only two conform to a regular bastion shape. No real application of co-ordinated flanking fire has been considered, the principal object being to sweep the curtains with fire from the casemates. The mushroom-shaped work is like a 15th-century boulevard. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)


Bouchain
A le Chemin de Douay
B Chemin de Valenciennes
D Chemin de Cambray

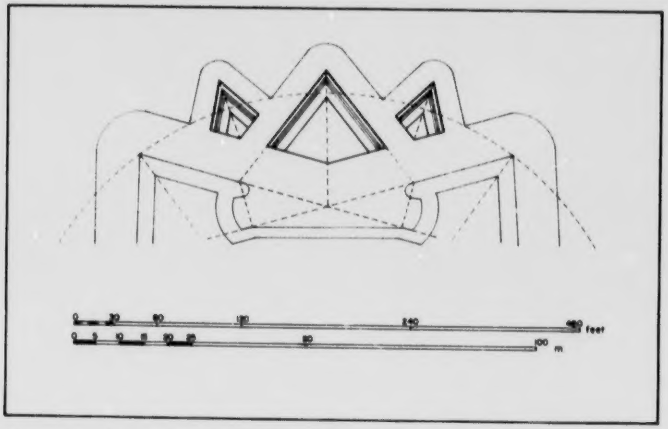
14 **Bouchain (Nord).** Late 16th-century defences: primitive boulevards and bastions. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)



15 **Bouchain.** Defences in 1676. The bastions have been modified to more regular shapes although the disposition of the flanks is not uniform. Outworks have been added on all sides of the square. Note the *queue d'ironde* covering the bastion, upper left, and the unusual horn-work to the right. (Collections du Ministère de la Défense, Bibliothéque du Génie, Paris.)



16 **Trace of pentagonal fortification:** bastions with orillons. (Drawing by T.M. Smith.)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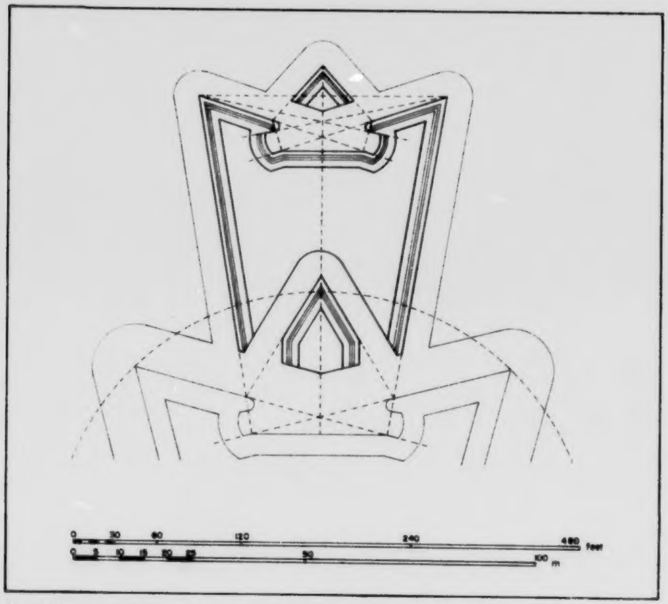
17 ***Demi-lune* and lunettes.** (Drawing by T.M. Smith.)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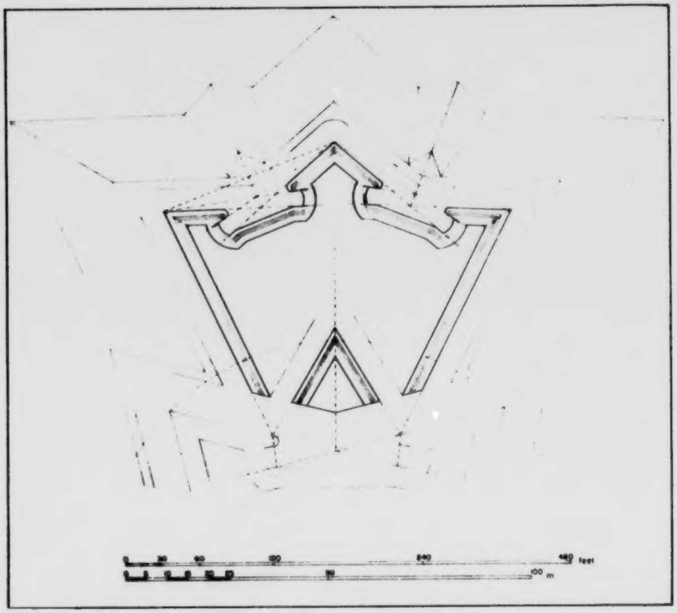
18 Horn-work with *demi-lune* and redoubt. (Drawing by T.M. Smith.)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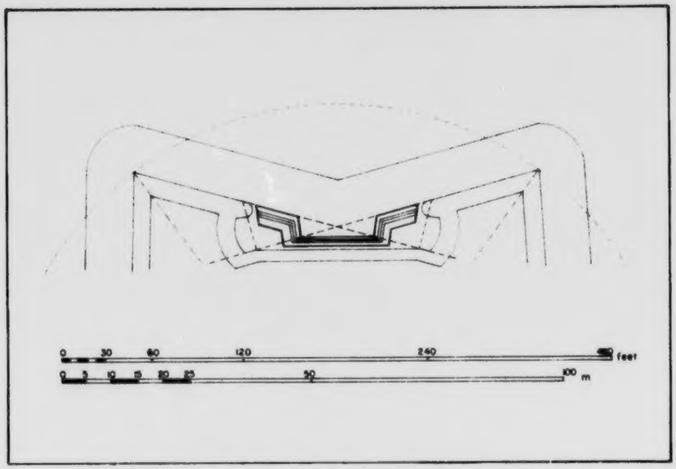
19 **Crown-work.** (Drawing by T.M. Smith.)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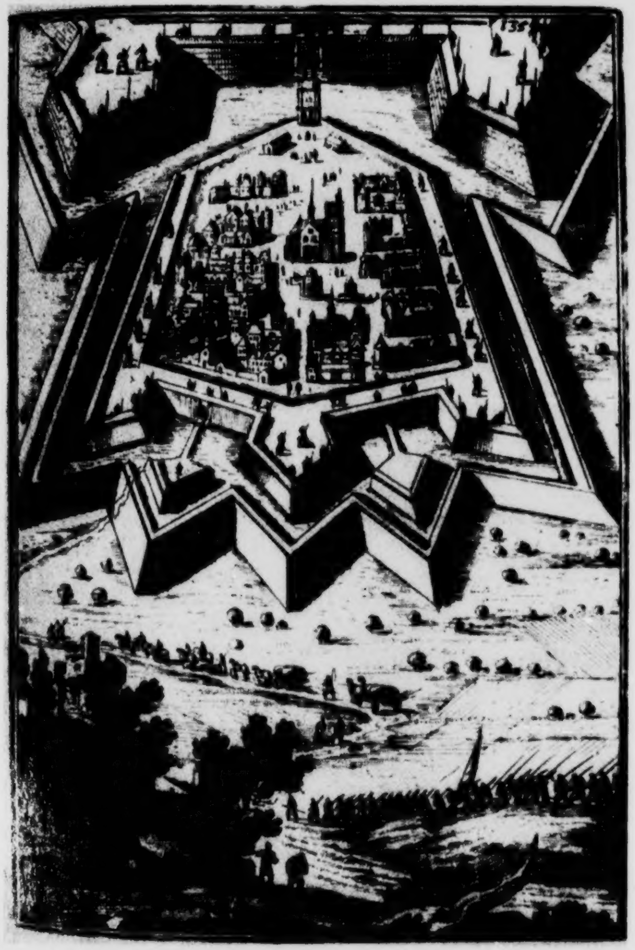
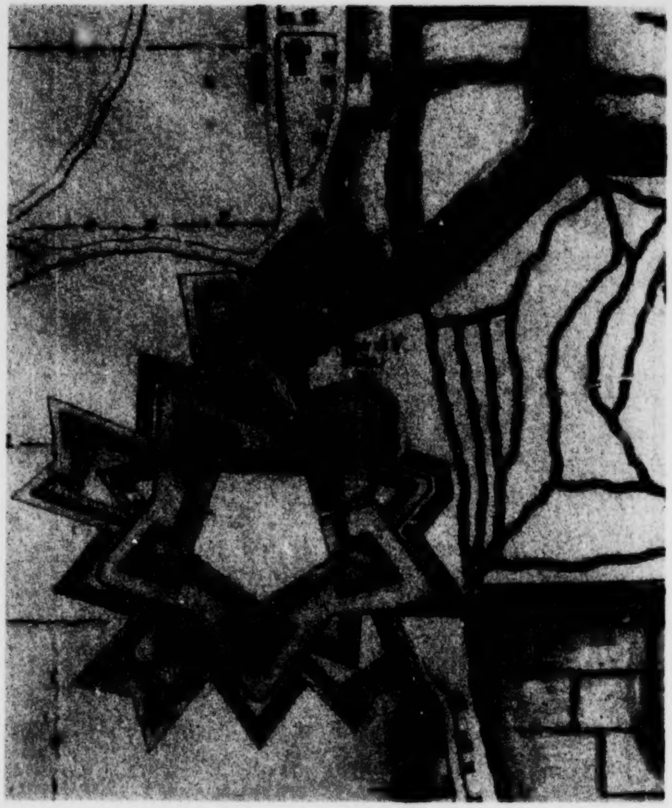
20 **Tenaille trace.** (Drawing by T.M. Smith.)

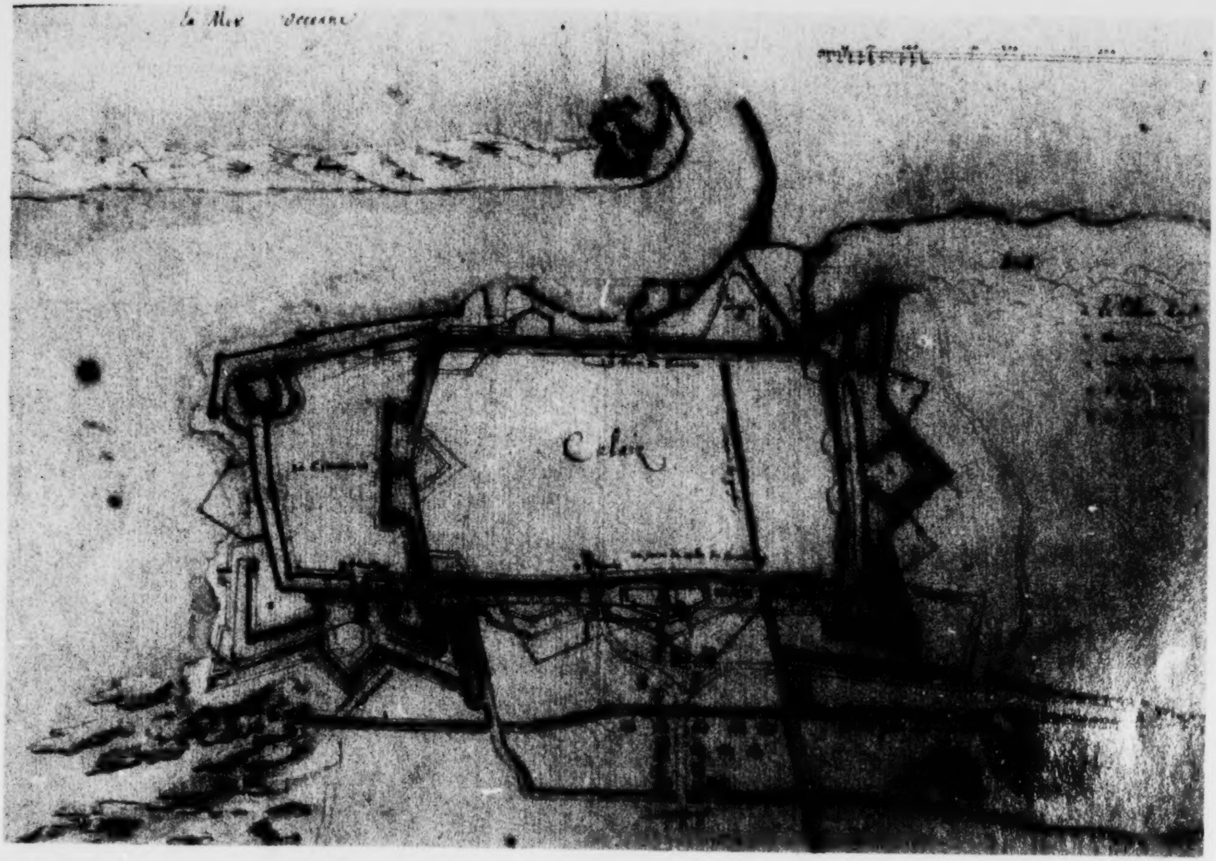
21 Sedan (Ardennes). The medieval château is surrounded by bastioned defences of the mid-16th century; the town was also provided with bastions at that time. Peculiar forked works create deep re-entrants in the Beauregard Bastion, the *fer à cheval* and the Bastion de Sillery. On the high ground overlooking the town and château, horn-works had to be added in the 17th century because the approaches were unprotected. Later plans show the extent to which Vauban strengthened the defences by retrenching the horn-works twice and sometimes three times, by adding *demi-lunes* and doubling the ditch and counterscarp on the town's weakest front. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)



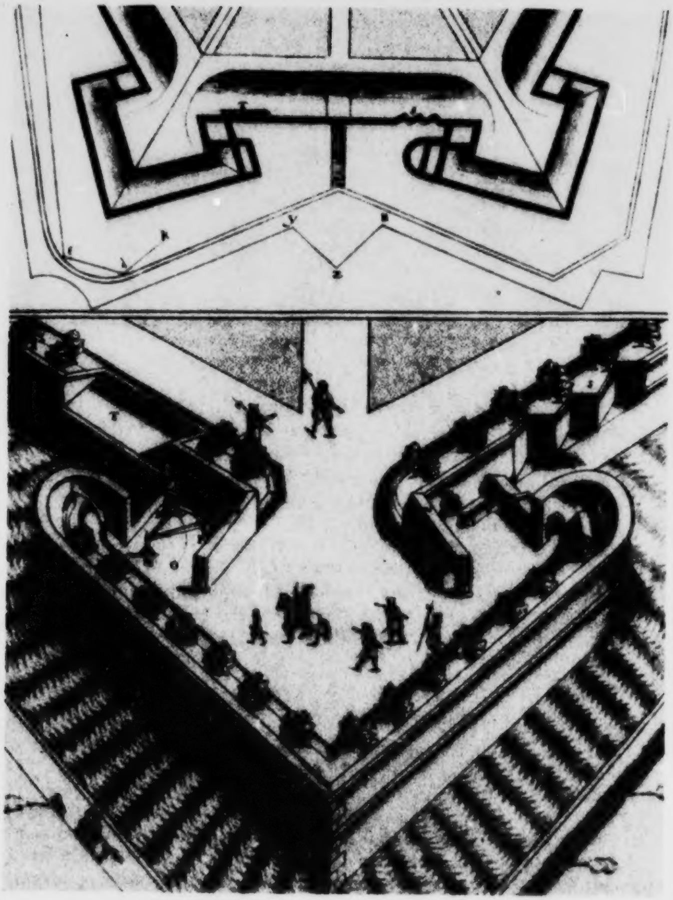
22 **Crown-work.** (Allain Manesson Mallet, *Les travaux de Mars ou l'art de guerre* [Paris, 1685], Vol. 1, p. 135.)



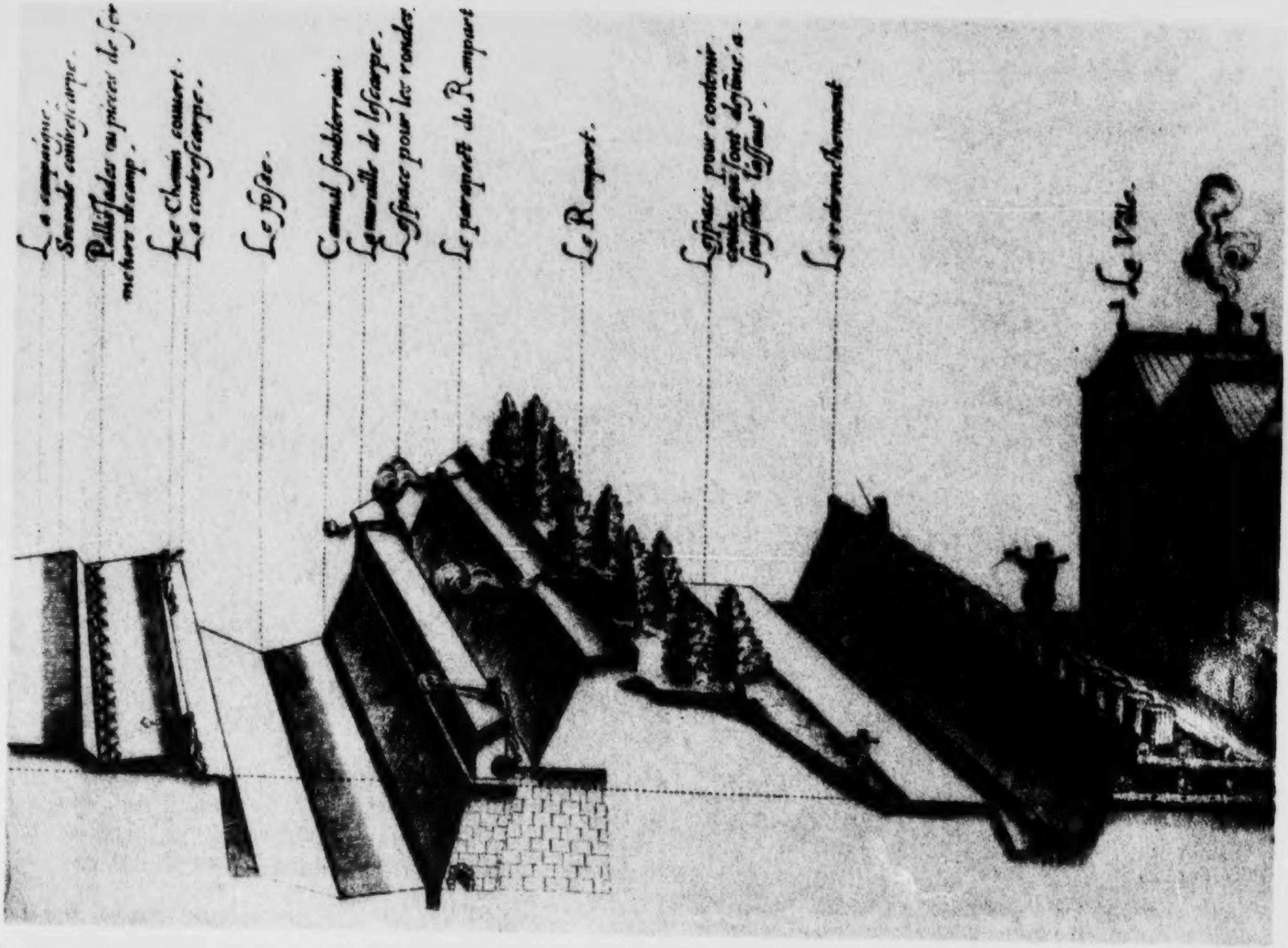
23 **Amiens (Somme).** The citadel built by Errard de Bar-le-Duc, ca. 1600. The town is on lower ground, surrounded by a medieval *enceinte* with round towers but no bastioned defences. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)



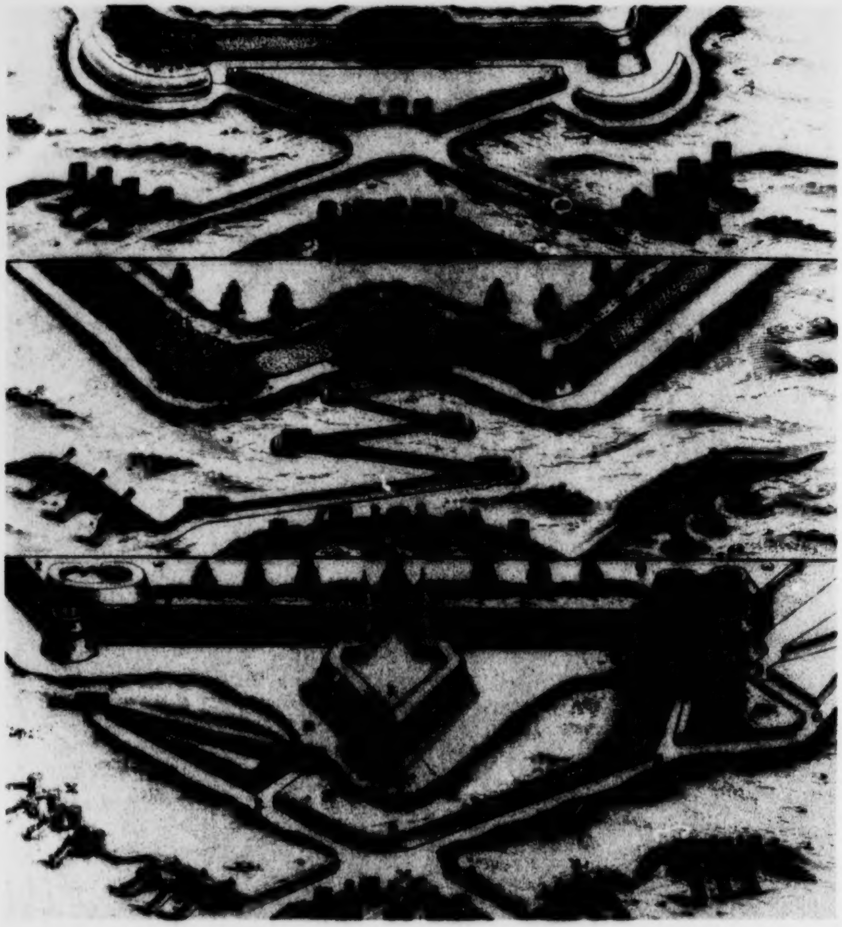
24 Calais (Pas-de-Calais). Early 17th-century defences. Calais was captured from the English by the French in 1558, at which time bastions were added. Held briefly by the Spanish (1595-98), the town was further improved by Errard de Bar-le-Duc after the French regained it. It is not possible to determine precisely what work is attributable to him, but the front of the citadel facing the town conforms closely to his fortification concepts, as does the front comprised of bastions D and E (lower left). (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)



25 **Bastion and front of fortification,** according to Errard. Acute re-entrant angles, resulting in greatly obscured flanks, are characteristic of Errard's system as is the height of the parapets and covered way, sufficient to protect a man on horseback. (Jean Errard de Bar-le-Duc, *La fortification demonstrée et réduicte en art* [Paris, 1620], p. 43.)


La campaigne.
Seconde contrescarpe.
Pallissades ou pieces de
Le Chemin couuert.
La contrescarpe.
Le fossé.
Canal soubterrain.
La muraille de lescarpe.
Lespace pour les rondes.
Le parapett du Rampart
Le Rampart.
Lespace pour contenir
Le retranchement
La Ville.

26 **Section across ramparts,** as Errard envisaged. Note the *chemin de ronde* below the parapet. (Jean Errard de Bar-le-Duc, *La fortification demonstrée et réduicte en art* [Paris, 1620], p. 22.)

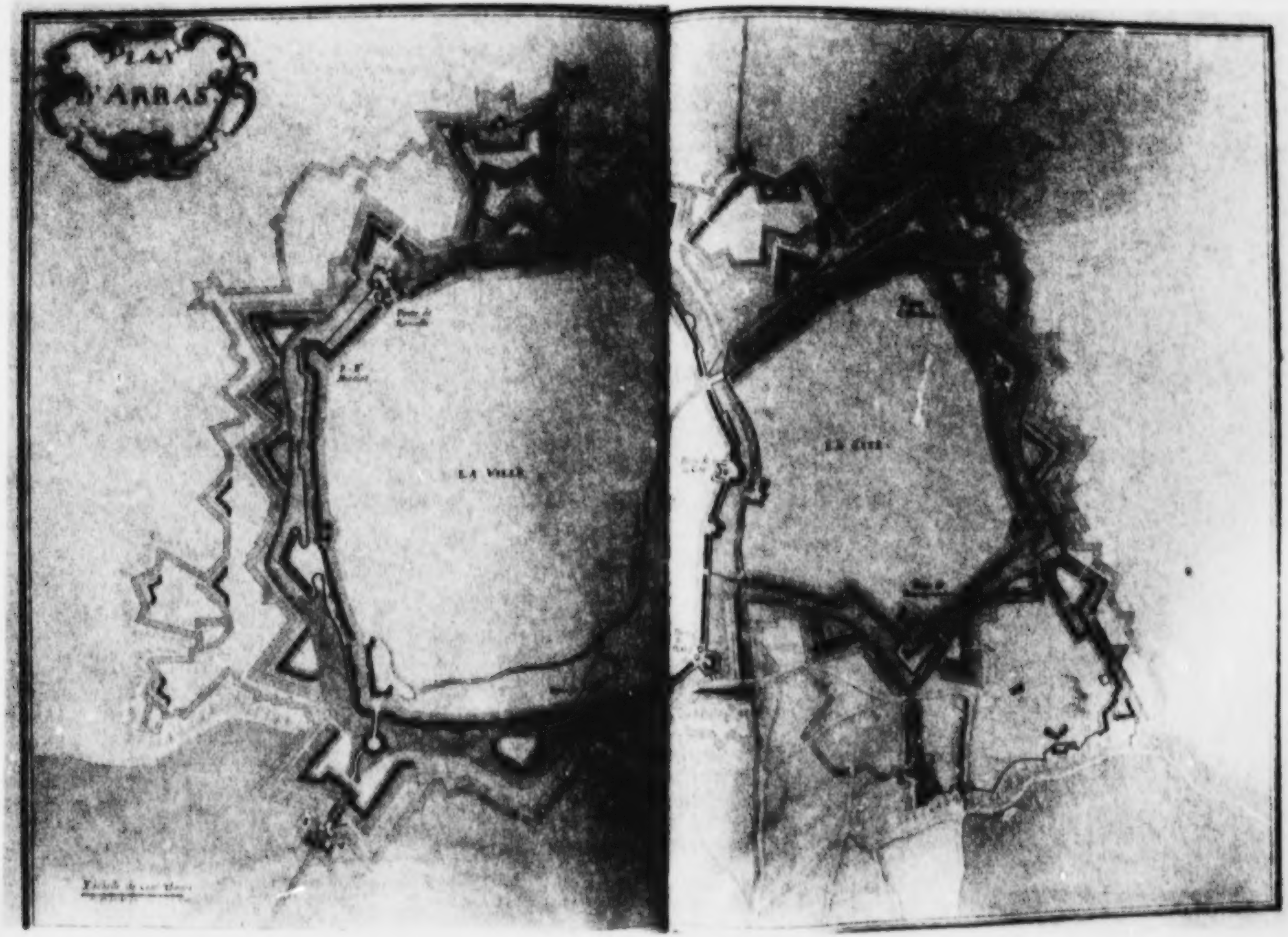


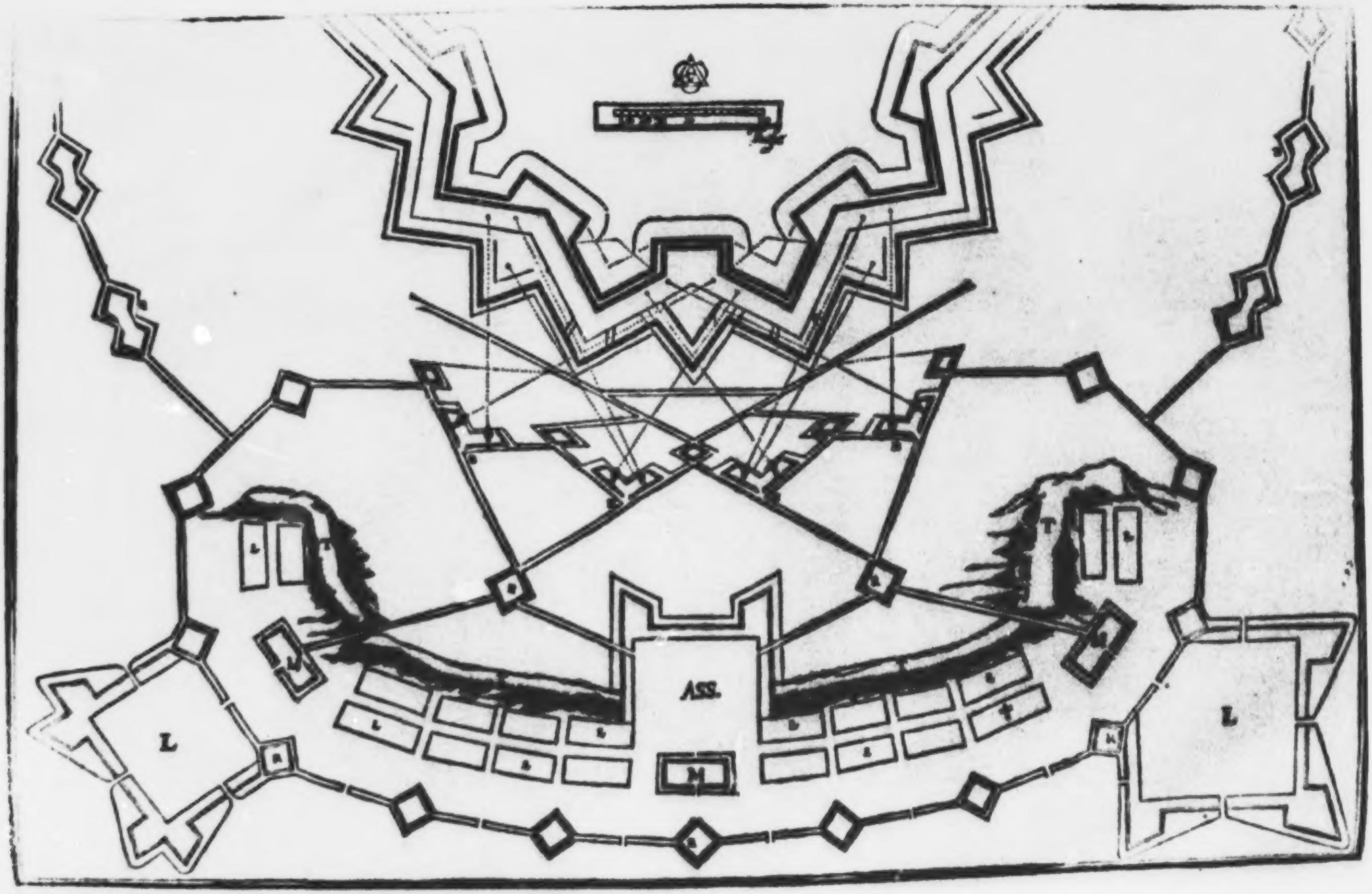
27 Scenarios for a siege. The walls to be breached are in all cases simple medieval ramparts with little capacity to resist or produce effective flanking fire. Only one bastion-like work is shown, covering the twin-tower gate (bottom centre). Note the crescent-shaped covers in front of the towers (top). (Jean Errard de Bar-le-Duc, *La fortification demonstrée et reduicte en art* [Paris, 1620], p. 25.)

28 Montreuil-sur-Mer (Pas-de-Calais). Medieval *enceinte* serving as a retrenchment to the bastioned front added at a lower level (left foreground) in early 17th century. Note the rectangular gun-port in the base of the round tower (upper right). (Photo by author.)

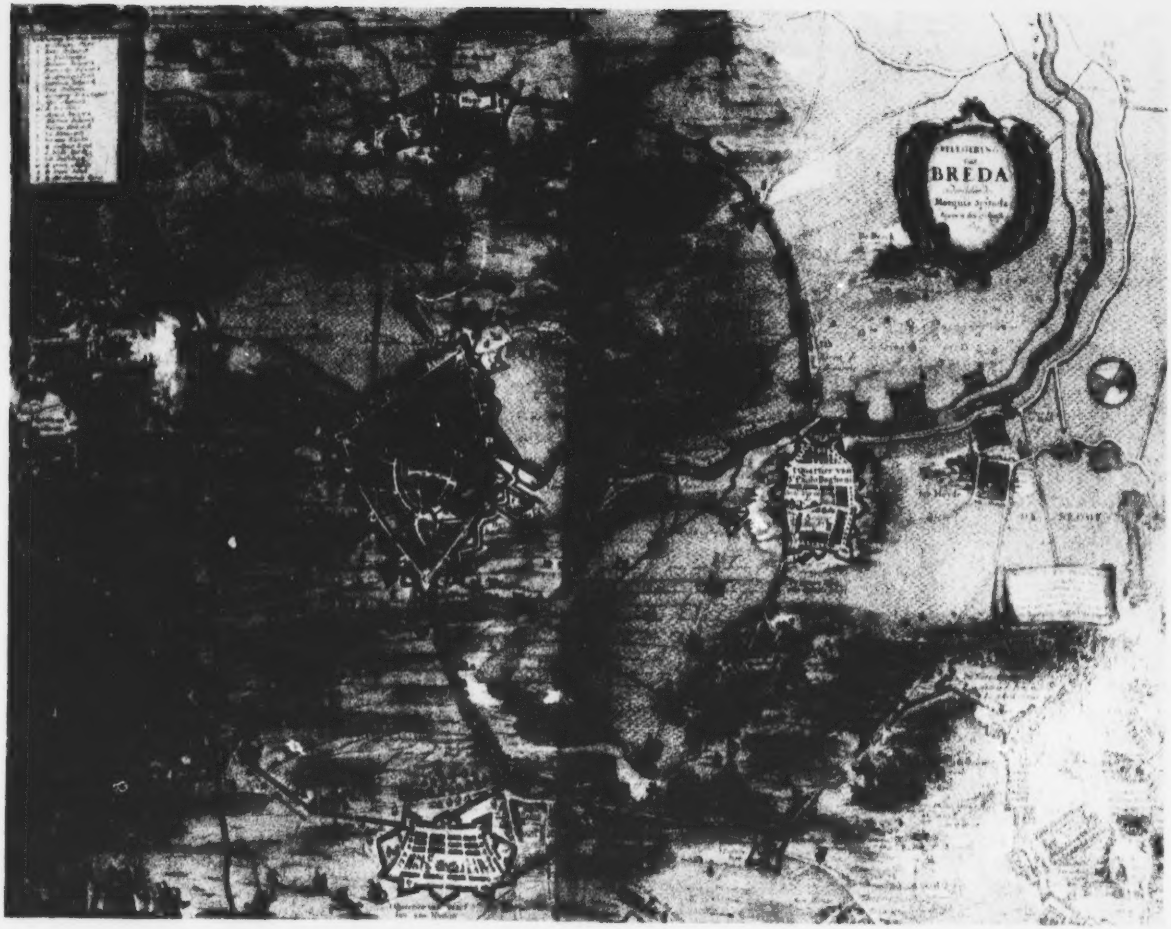
29 Arras (Pas-de-Calais). Fortifications of the town, early 17th century. The basic *enceinte* is a medieval wall defended with round towers, but the addition of several gun towers, prior to the development of bastions, is apparent in the circular and irregular shapes around the perimeter. Several bastions, with elongated *orillons* reminiscent of the early Italian school, have been incorporated in an outer *enceinte*, probably at a lower level. The most prominent feature is the array of outworks in masonry and earth located across the ditch on all fronts; some conform to recognizable fortifications such as horn-works and *demi-lunes*, but most are irregular works presenting a series of re-entrants to the country.

The town was taken from the Spanish by the French in 1640. The plan is undated but was part of a collection made by de Clerville, Vauban's immediate predecessor and may be placed in the period 1650-60. A similar plan, dated 1641, shows the same disposition of fortifications, which may therefore be attributed to Spanish rather than to French construction. The defences were strengthened and improved in the 1660s by Vauban, who added a citadel above the "Cité" as a means of controlling the populace. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)

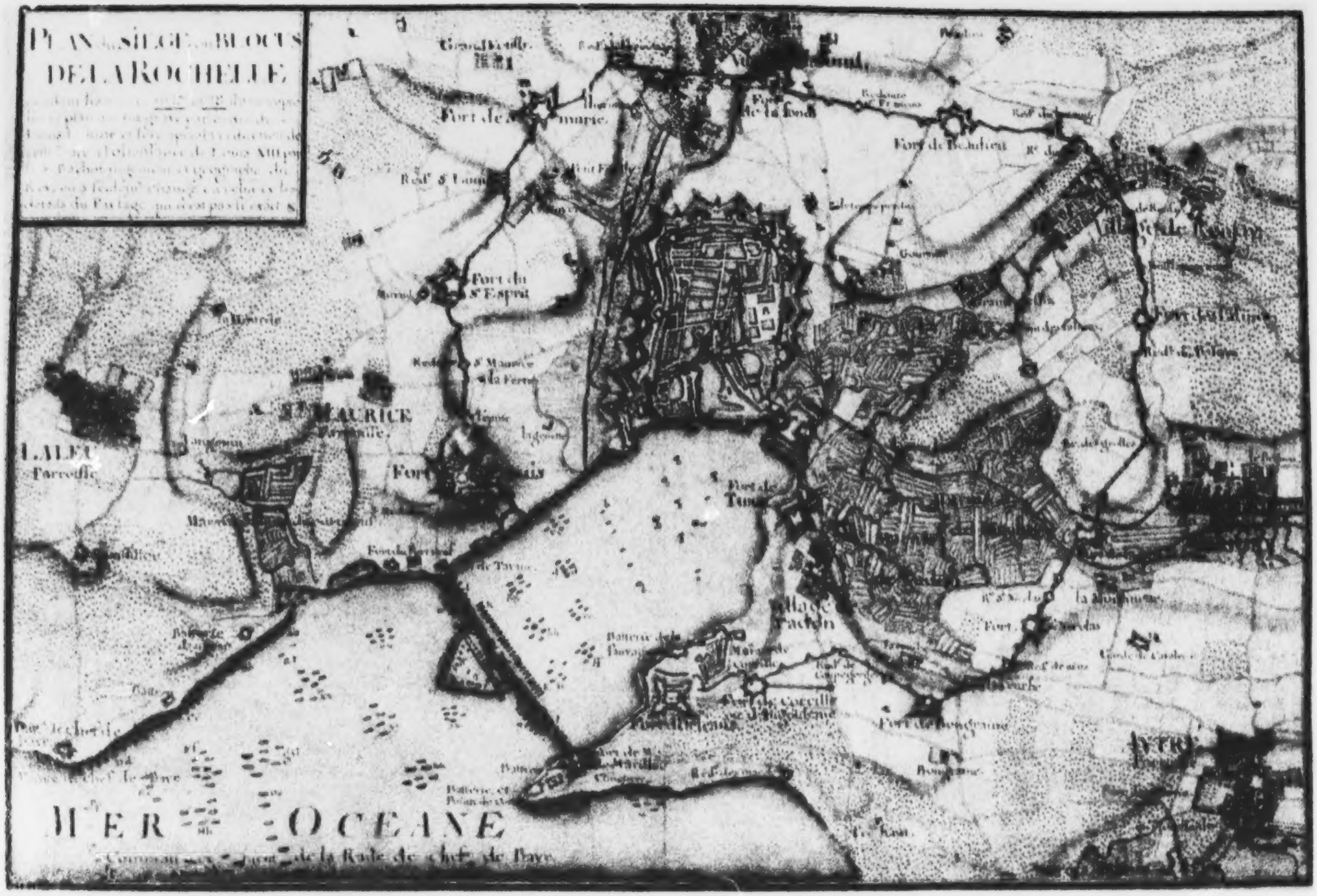

PLAN D'ARRAS
LA VILLE
LA CITE



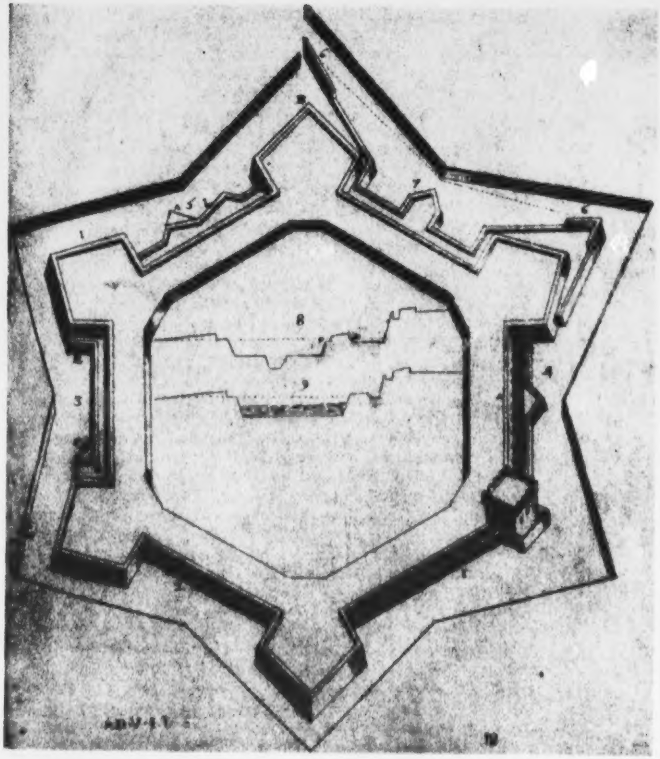
30 **Sophistication in siegecraft.** Fortified camps and continuous lines of trenches surround the place under attack. Trenches with enlarged areas for positioning artillery batteries are pushed forward in stages towards the front under attack. (Sieur de Fabre, *Les practiques sur l'ordre et regle de fortifier, garder, attaquer et deffendre les places* [Paris, 1629].)



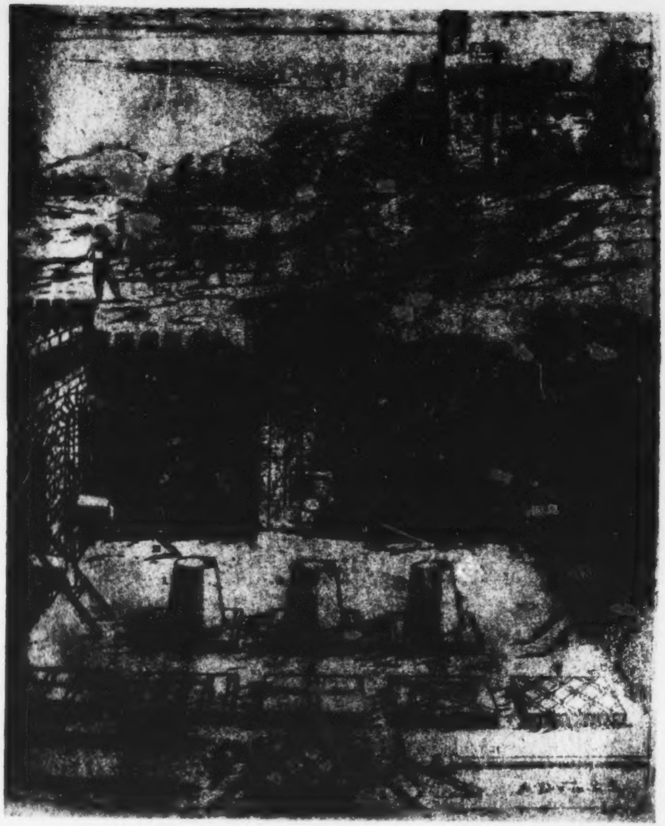
31 Breda (Netherlands). The celebrated siege of the Dutch town by Spanish forces under Spinola, 1624. The town, surrounded by a simple rampart from which bastions project, derives its main defence from the water-filled ditch and the series of horn-works and covered way beyond. The besieging army's series of fortified camps dwarf the town they encircle. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)


PLAN du SIEGE ou BLOCUS
DE LA ROCHELLE
Fort de Ste marie
Fort de la Font
Fort de Beaulieu
Fort du St Esprit
St MAURICE
LALEU
Fort de la Tasse
Fort de Bongraine
MER OCEANE

32 La Rochelle (Charente-Maritime). The siege of the Huguenot stronghold, 1627-28. The town, defended by a bastioned *enceinte* and outworks surrounding the medieval walls, is encircled by a ring of interconnected redoubts and forts constructed by the royalists. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)

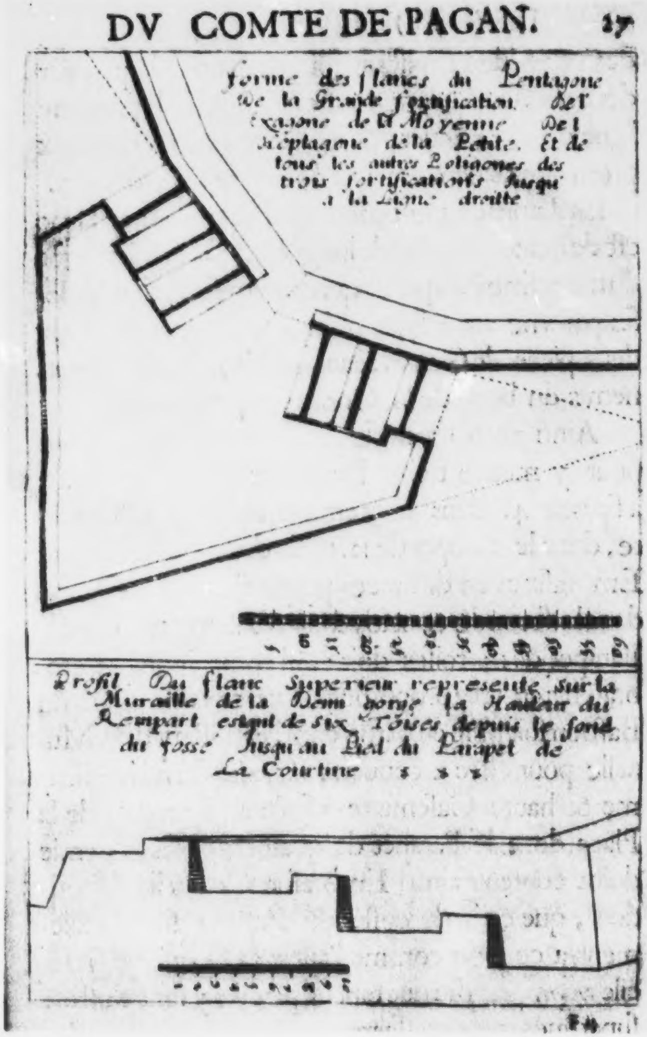


33 A typical bastioned fortification as envisaged by de Ville. The bastions flanks are at 90 degrees to the curtains. Variations of *fausse-braies* are shown on each front and in section. That on front 3 in particular foreshadows Vauban's tenaille. (Antoine de Ville, *Les fortifications, attaques & défences des places*.... [Lyon, 1628] p. 127.)

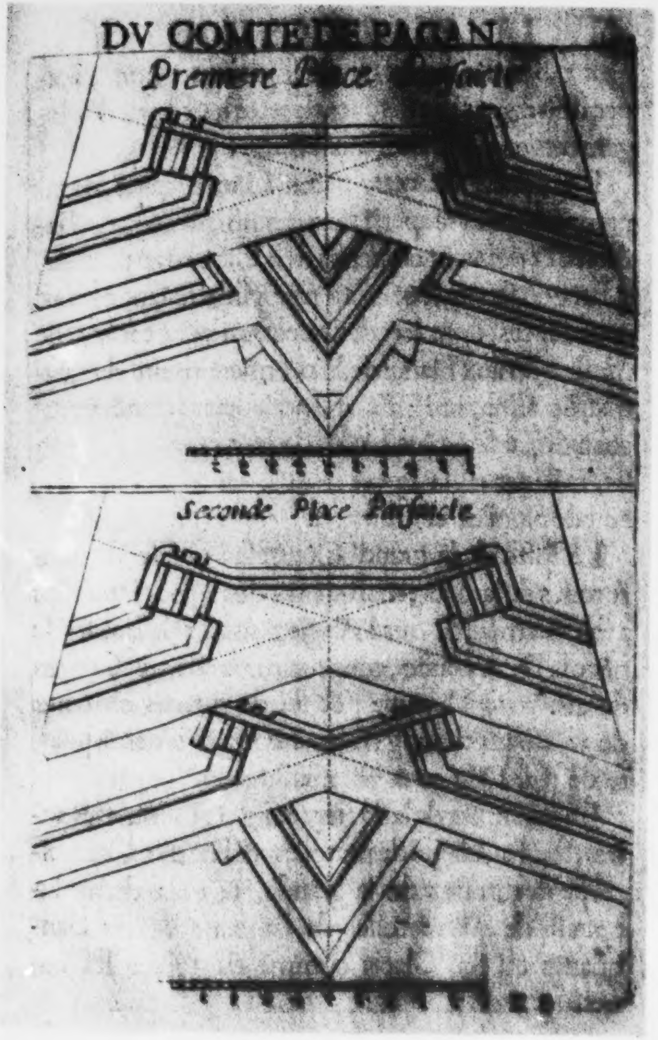


34 Petards. An essentially Renaissance device for removing a door. (Antoine de Ville, *Les fortifications, attaques & défenses des places*.... [Lyon, 1628], p. 255.)

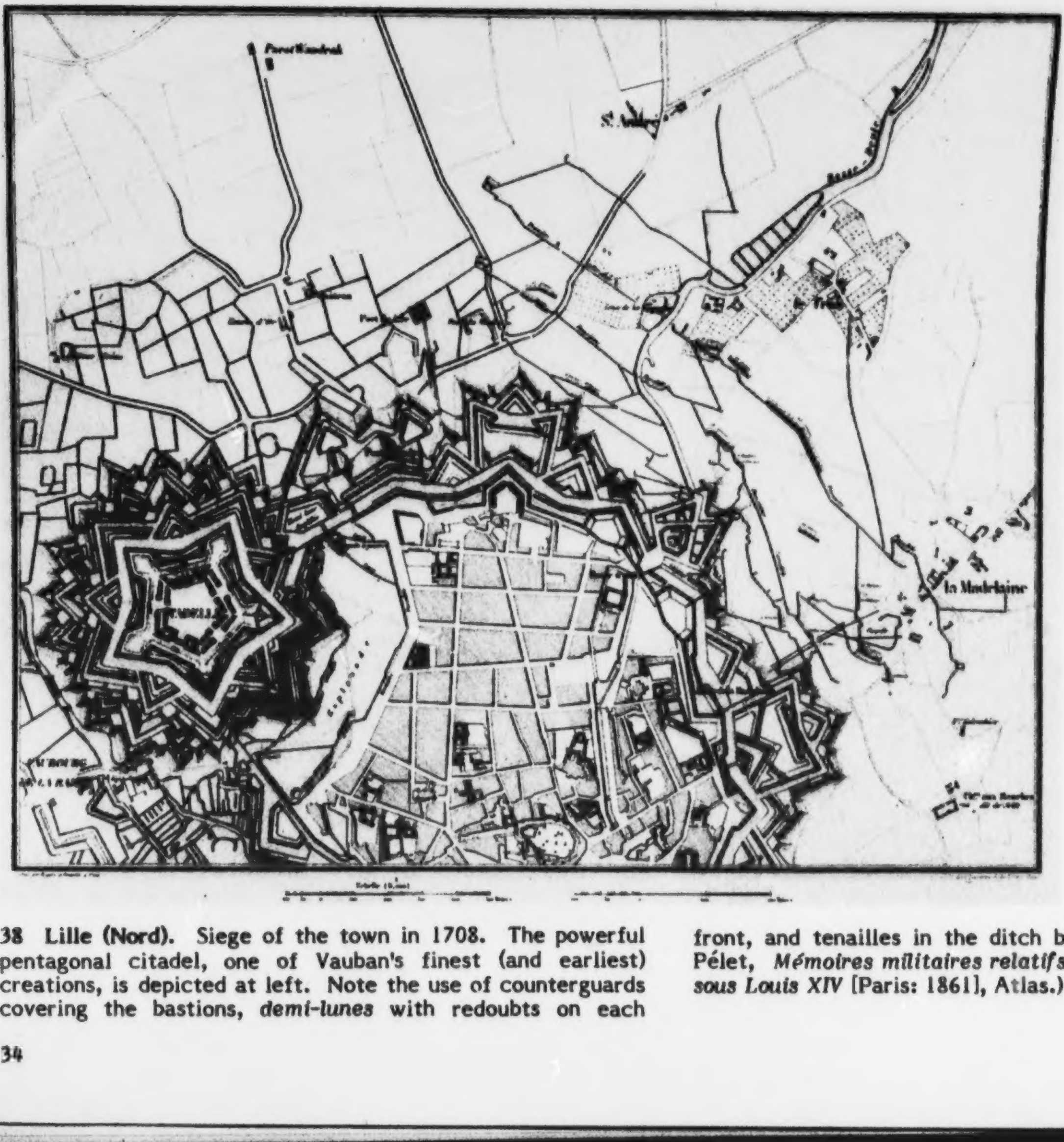
35 Saint-Martin-de-Ré (Charente-Maritime). *Orgues:* iron-tipped beams forming a barrier across the entranceway to the citadel. (Photo by author.)


DV COMTE DE PAGAN. 27
Forme des flancs du Pentagone de la Grande fortification. De l'Exagone de la Moyenne. De l'Heptagone de la Petite. Et de tous les autres Poligones des trois fortifications iusqu'a la Ligne droitte
Profil Du flanc Superieur represente sur la Muraille de la Demi gorge la Hauteur du Rempart estant de six Toises depuis le fond du fossé Jusqu'au Pied du Parapet de La Courtine

36 Pagan's system, relying on concentration of artillery in the flanks. The multi-tiered effect is shown in section. (Blaise François Pagan, *Les Fortifications* [Paris, 1645], p. 27.)

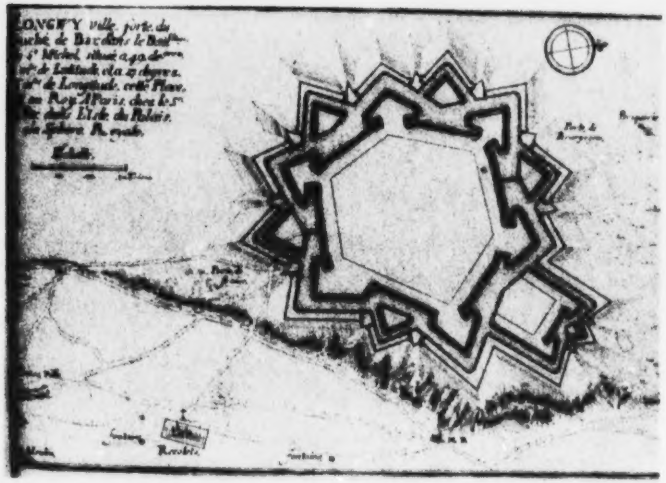

DV COMTE DE PAGAN.
Premiere Place Parfaicte
Seconde Place Parfaicte

37 Defence in depth. Pagan's improved system, showing counterguards in front of bastions, a concept Vauban later applied. Note the lines of defence prolonging the alignment of the faces into the re-entrant angles. (Blaise François Pagan, *Les Fortifications*[Paris, 1645], p. 43.)

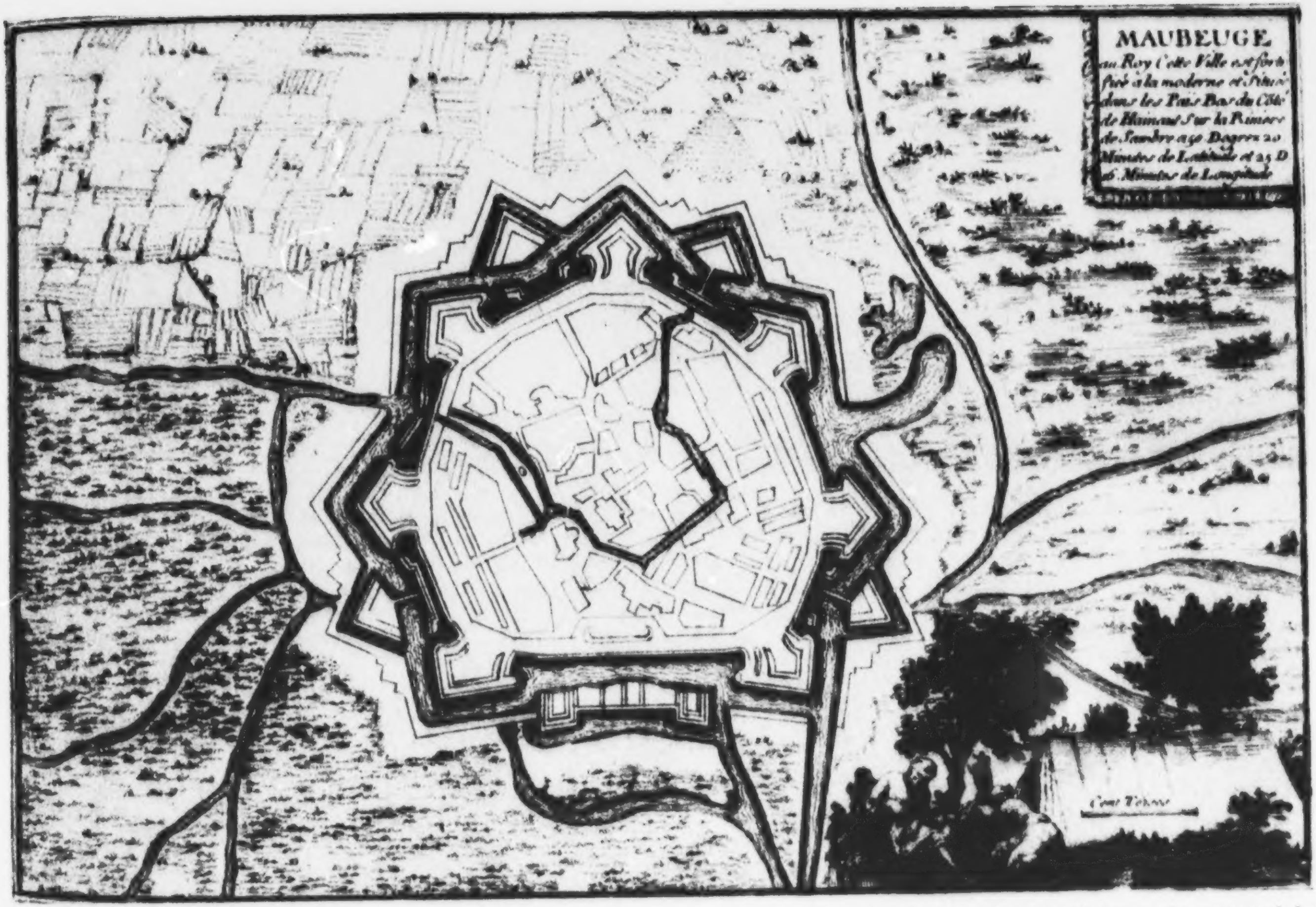


38 Lille (Nord). Siege of the town in 1708. The powerful pentagonal citadel, one of Vauban's finest (and earliest) creations, is depicted at left. Note the use of counterguards covering the bastions, *demi-lunes* with redoubts on each front, and tenailles in the ditch before the curtains. (J.J. Pélet, *Mémoires militaires relatifs à la succession d'Espagne sous Louis XIV* [Paris: 1861], Atlas.)

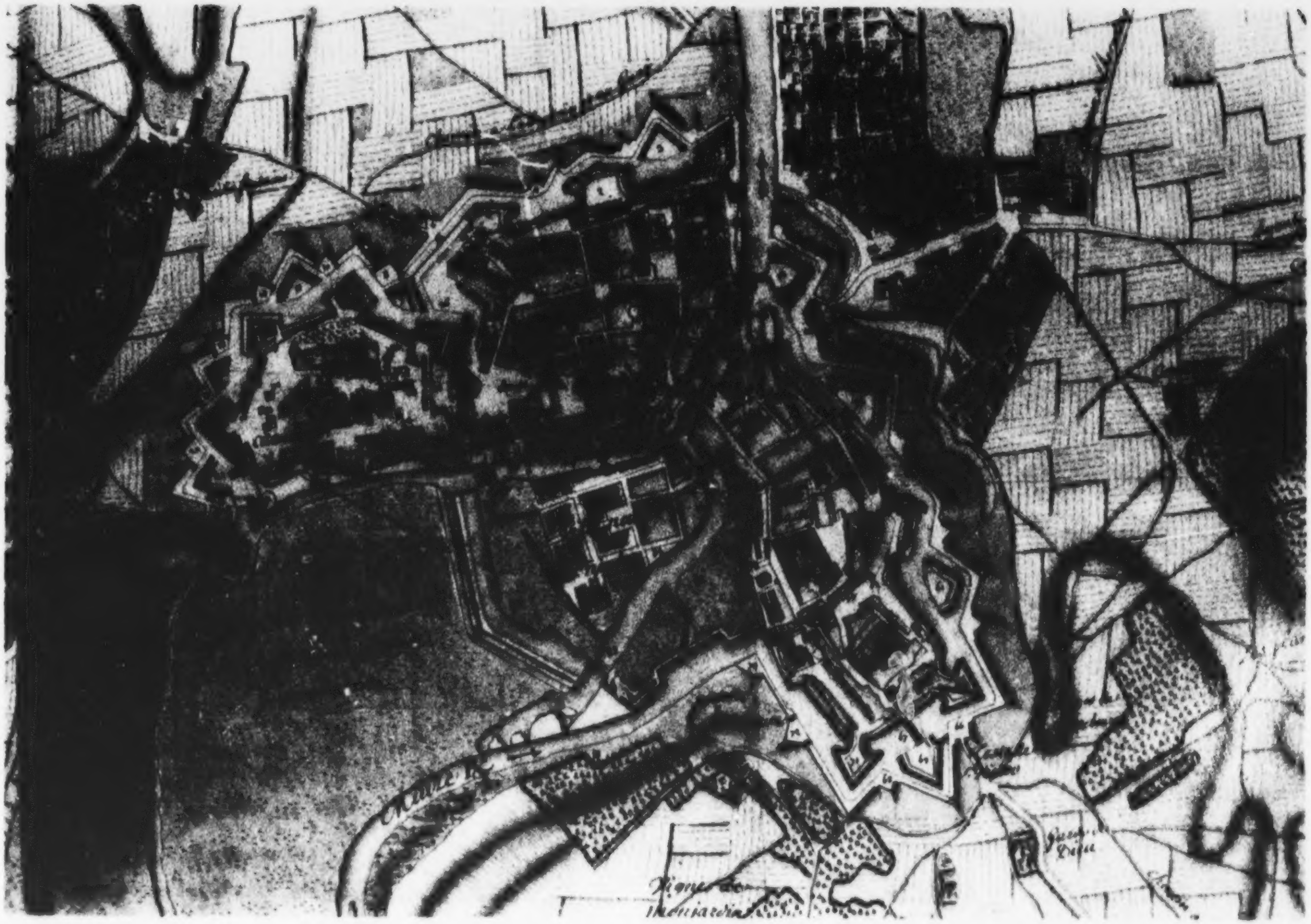
39 Lille. The citadel. Simple tenaille of earth masks the foot of the curtain. Face of bastion to left. (Photo by author.)



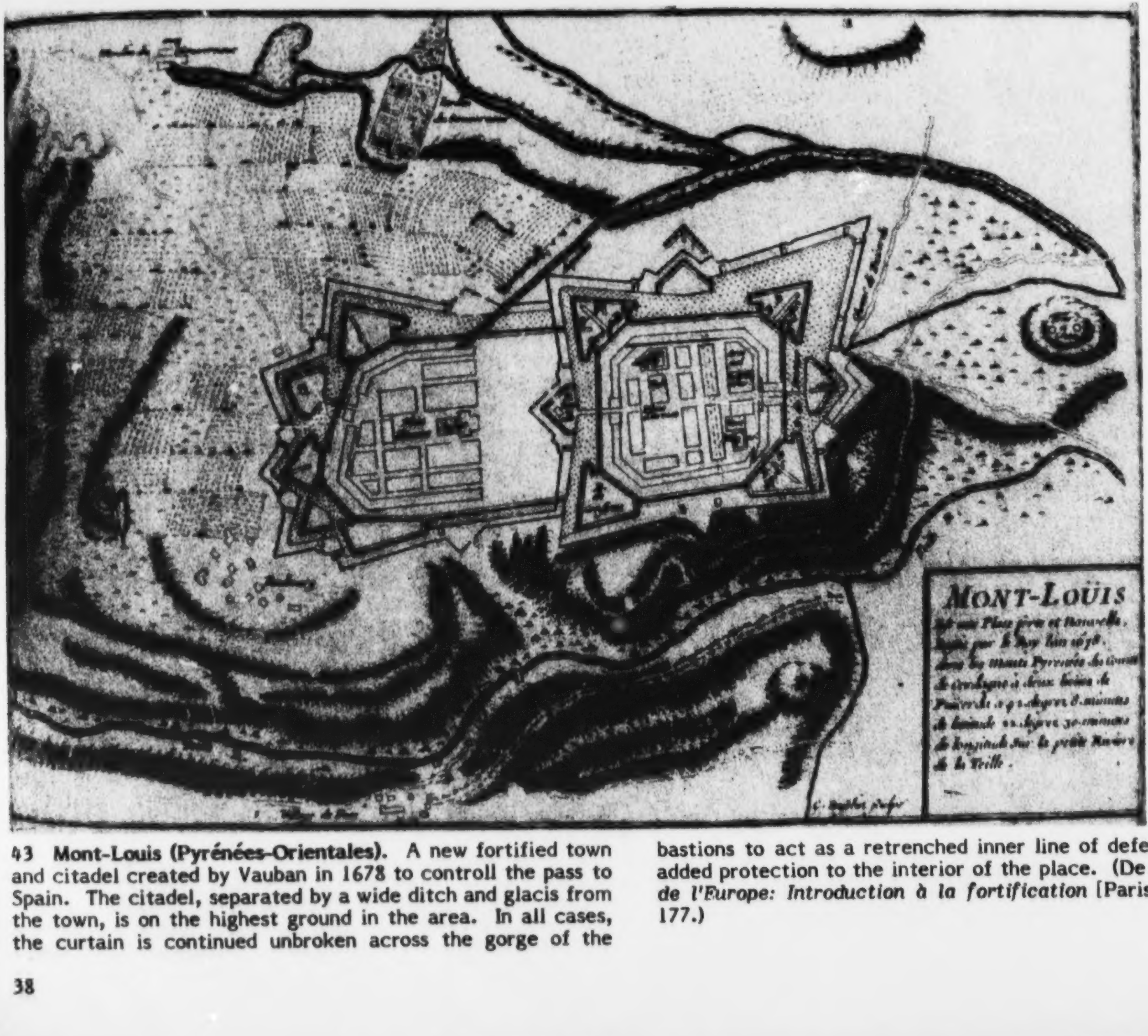
40 Longwy (Meurthe-et-Moselle). The fortified town built by Vauban. *Orillons*, curved flanks and *brisures* are used on the curtains on all fronts most susceptible to attack. The weakest front is covered by a massive horn-work. (De Fer, *Force de l'Europe: Introduction à la fortification* [Paris, 1695], p. 52.)


MAUBEUGE
au Roy Cette Ville est forti
fiée à la moderne et Située
dans les Pais Bas du Côté
de Hainaut Sur la Rivière
de Sambre a 50 Degrés 20
Minutes de Latitude et 25 D
46 Minutes de Longitude
Cent Toises

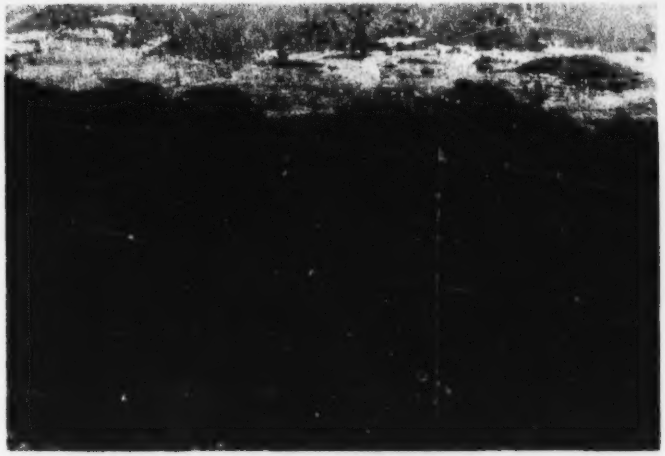
41 Maubeuge (Nord). The town as re-fortified by Vauban, 1679-85. The plan is an irregular heptagon relying on a wet ditch as the main outer defence. All bastions have *orillons* and curved flanks. Tenailles are used on all but one front where a natural expanse of water serves as adequate defence and another where the elongated front is covered by an expanded tenaille or foreshortened horn-work. (De Fer, *Force de l'Europe: Introduction à la fortification* [Paris, 1695], p. 78.)



42 Verdun (Meuse). Fortifications as improved by Vauban in the 1670s. Citadel built by Errard de Bar-le-Duc is retained at left, with outworks added. The *faubourg* St. Victor is defended by a horn-work consisting of two full bastions with *orillons*. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)



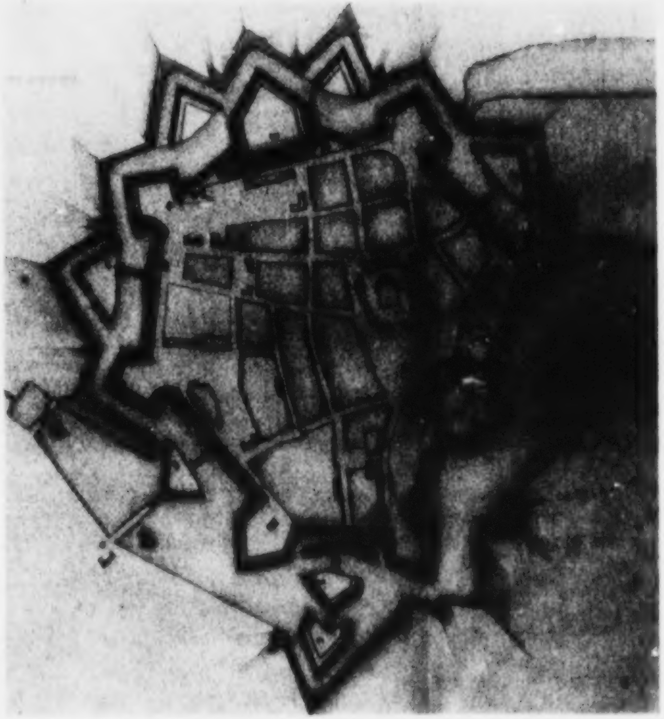
43 **Mont-Louis (Pyrénées-Orientales).** A new fortified town and citadel created by Vauban in 1678 to controll the pass to Spain. The citadel, separated by a wide ditch and glacis from the town, is on the highest ground in the area. In all cases, the curtain is continued unbroken across the gorge of the bastions to act as a retrenched inner line of defence and an added protection to the interior of the place. (De Fer, *Force de l'Europe: Introduction à la fortification* [Paris, 1695], p. 177.)



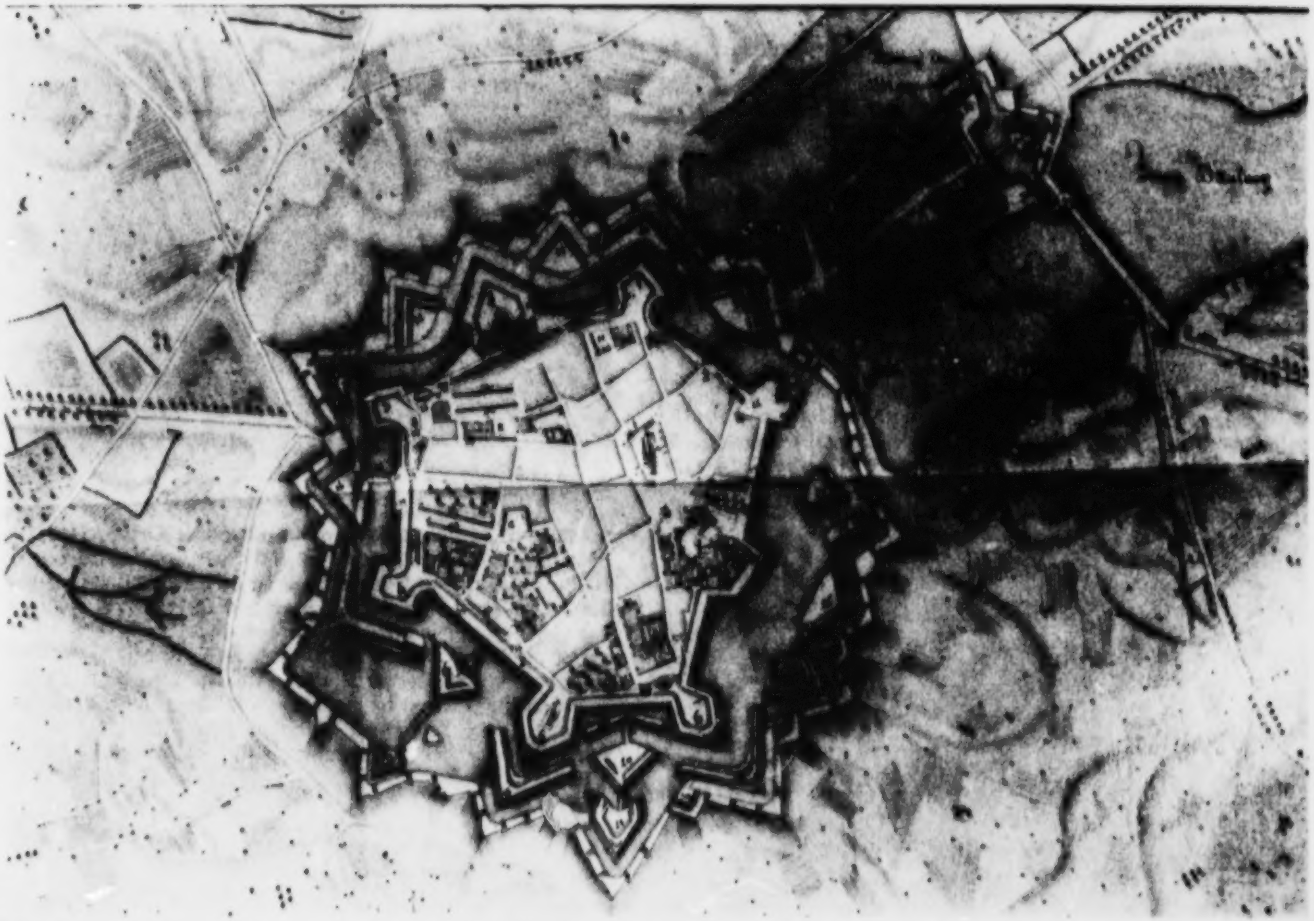
44 Mont-Louis. Bastion with *orillons* and curved flanks. Note the well-preserved covered way with traverses screening the *place d'armes* (lower right). (Photo by author.)

45 Mont-Louis. Curved flank with embrasures, covered by an *orillon*. (Photo by author.)

46 Le Quesnoy (Nord). A small town in the Spanish Netherlands, captured by the French in 1654. Plan shows the irregular, primitive, bastioned defences of the late 16th century. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)

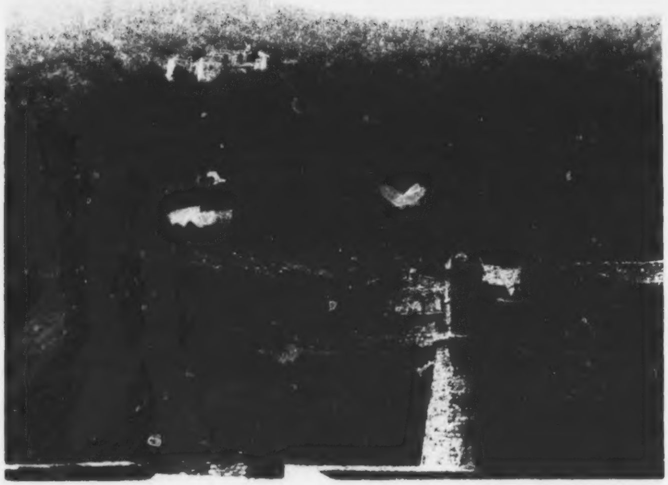


47 Le Quesnoy. The fortifications as improved by Vauban in 1679. The original pentagonal *enceinte* has been expanded to include eight irregular fronts, including one large, centrally located bastion with a retrenchment across the gorge. Two *demi-lunes* in line cover the constricted front (bottom). (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)



48 Le Quesnoy. Late 18th-century plan of fortifications. Outworks in the form of counterguards, *demi-lunes* and redoubts in the *place d'armes* have been added to Vauban's defences. The *faubourg* is enclosed in the horn-work (upper right). (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)

49 Le Quesnoy. Detail of bastion with *orillon* constructed by Vauban. Into the brick escarp are keyed long slabs of granite, the heads appearing as white dots interspersed on the face of the wall. Communication to the outworks is through a tunnel in the counterscarp (centre right). (Photo by author.)

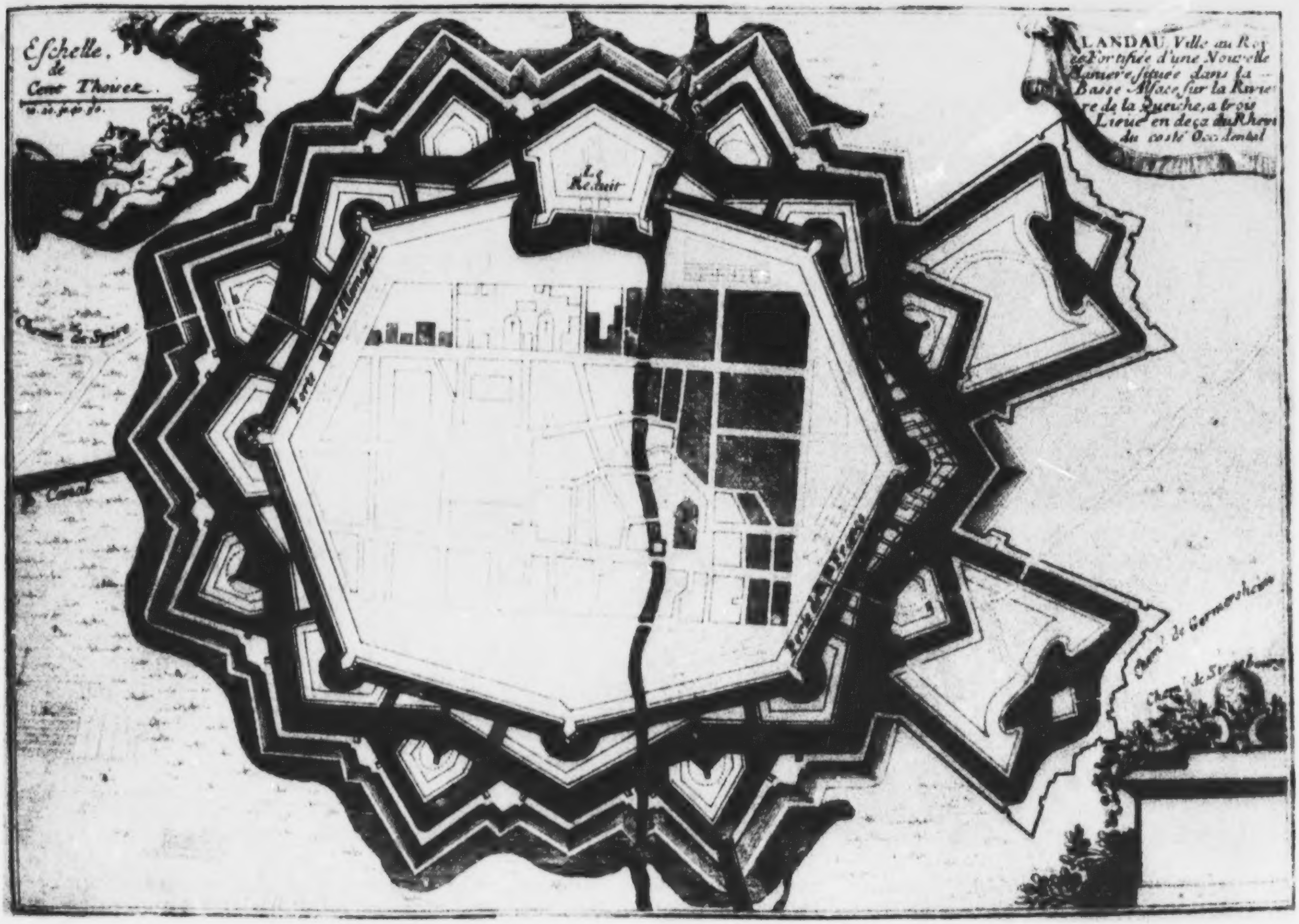


50 Villefranche-de-Conflent (Pryénées-Orientales). The east front, looking at the right face, *orillon* and flank of Bastion Dauphin. Note the masonry additions to the parapet for increased protection (part of Vauban's improvements to the 16th-century and earlier defences), also the tiled roof covering the rampart on the curtain at left. A series of intercommunicating artillery positions, also built by Vauban, culminating in the fort on top of the neighbouring height, command the town and defences from the rear in case an enemy succeeded in storming the ramparts. (Photo by author.)

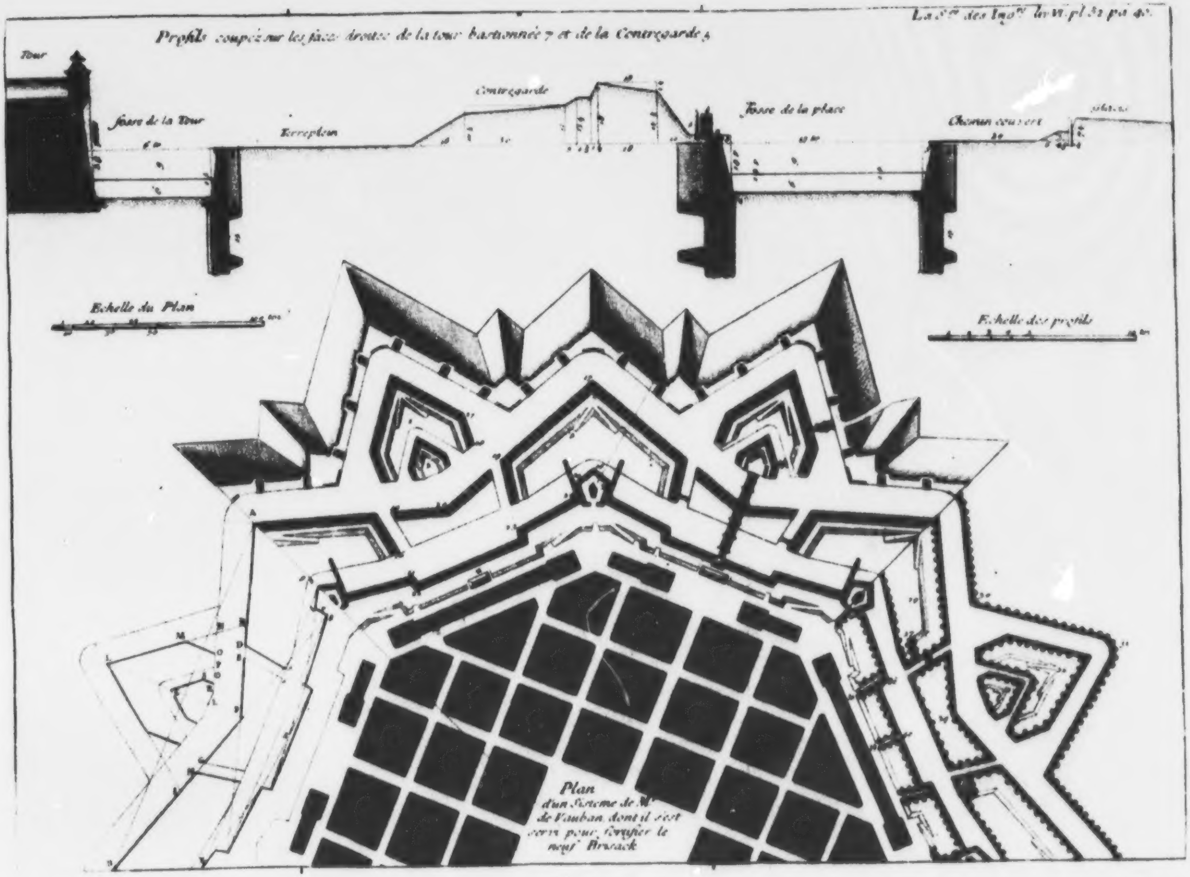
51 Villefranche-de-Conflent. Bastion de la Reine. Unusually high embrasures protected gunners. Note also masonry traverse screening interior of bastion (upper right) and covered rampart on left. (Photo by author.)

52 Besançon (Doubs). *Tour bastionnée* of Vauban's so-called "second system." (Photo by author.)

53 **Entrevaux (Alpes-de-Haute-Provence).** *Tours bastionnées* added by Vauban to the medieval wall at the river's edge. The zigzag, protected communication, interspersed with traverses, leads to the commanding height above the town. (Photo by author.)


Eſchelle de Cent Thoiſes
10. 20. 30. 40. 50.
LANDAU Ville au Roy
est Fortifiée d'une Nouvelle
Maniere ſituée dans la
Basse Alſace ſur la Rivie
re de la Queiche, a trois
Lieue en deça du Rhein
du costé Occidental
Le Reduit
Chemin de Spire
Canal
Porte d'Allemagne
Porte de France
Chem. de Germersheim
Chem. de Strasbourg

54 Landau (Germany). Vauban's "second system": *tours bastionnées* with detached bastions covering them. Conventional bastion forms are used in the horn-works at right. (De Fer, *Force de l'Europe: Introduction à la fortification* [Paris, 1695], p. 127.)


La Sce des Ingrs liv.VI. pl. 32 pa. 40.
Profils coupés sur les faces droites de la tour bastionnée 7 et de la Contregarde 5
Tour
fossé de la Tour
Terreplein
Contregarde
Fossé de la place
Chemin couvert
glacis
Echelle du Plan
Echelle des profils
Plan
d'un Sisteme de Mr
de Vauban dont il s'est
servi pour fortifier le
neuf Brisack

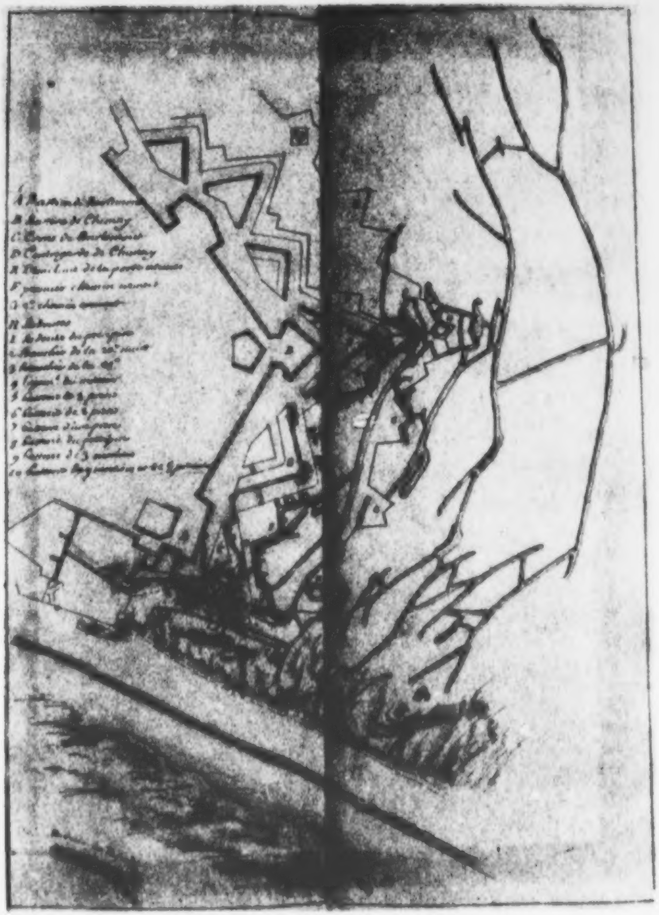
55 Neuf-Brisach (Haut-Rhin). Vauban's "third system" of *tours bastionnées* set in a curtain which itself has re-entrants to provide flanking fire. The towers are covered by counterguards or detached bastions; *demi-lunes* retrenched with redoubts are on every front, with tenailles screening the curtains. The escarp of the counterguard is demi-revetted, the top of the masonry being crowned with a hedge of thorns, behind which is a palisade. (Belidor, *La science des ingénieurs dans la conduite des travaux de fortification et d'architecture civile* [Paris: Jombert, 1729], Bk. 6, p. 40.)

56 Neuf-Brisach. Increased flanking fire. The re-entrant in the curtain, with its casemated artillery position, is in left foreground; the *tour bastionnée* with additional embrasures is upper centre; counterguard at right. (Photo by author.)

57 Neuf-Brisach. Defence in depth: *demi-lune* in foreground, with tenaille revetment appearing above it (centre left); face and flank of counterguard at right. At rear, the curtain of the main *enceinte*; roof of barracks on skyline. (Photo by author.)

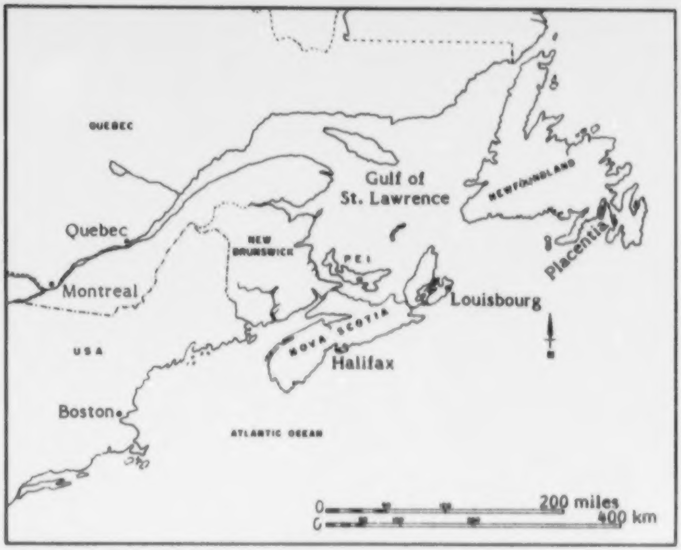
58 Philippsburg (Germany). The siege of 1688, directed by Vauban. The town occupied a powerful position overlooking the Rhine, passage of which was guarded by a bridgehead on the opposite bank. The inset shows the approach to the town covered in turn by a horn-work and a crown-work on the rising ground. Once the bridgehead had been taken, the French crossed the river and spread out on both sides of the approach in order to take first the horn-work, then the crown-work. At the same time, another attack was opened on the defences of the town itself. Note the positioning of the artillery batteries used to silence flanking fire at long range and to breach the walls at close range. The upper attack shows the use of batteries in conjunction with the classic "three parallels" approach, the third parallel being at the foot of the glacis. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)

PLAN



59 Luxembourg (Duchy of Luxembourg). Detail of the siege of 1684, conducted by Vauban. The largest and most powerful fortress of the Spanish Netherlands, Luxembourg was situated on high ground with rocky ravines on three sides. All approaches were difficult, and only the northwest one offered sufficient open ground for extensive siegeworks. Vauban coordinated attacks on five fronts simultaneously to prevent the defenders from being able to concentrate their forces. The main attack was on the northwest, supported by artillery on the Pasendal heights across the river. The three parallels, communicating trenches and battery locations enveloped the front in a wide arc. Note also the saps pushed forward to crown the glacis and the mines at the salient of the counterguard D. After the siege, Vauban considerably strengthened the defences of the town and added detached works on all neighbouring heights. Covering the ground over which he had been able to advance the main attack, he established a ring of powerful redoubts in the *places d'armes* of the pre-existing outer glacis. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)

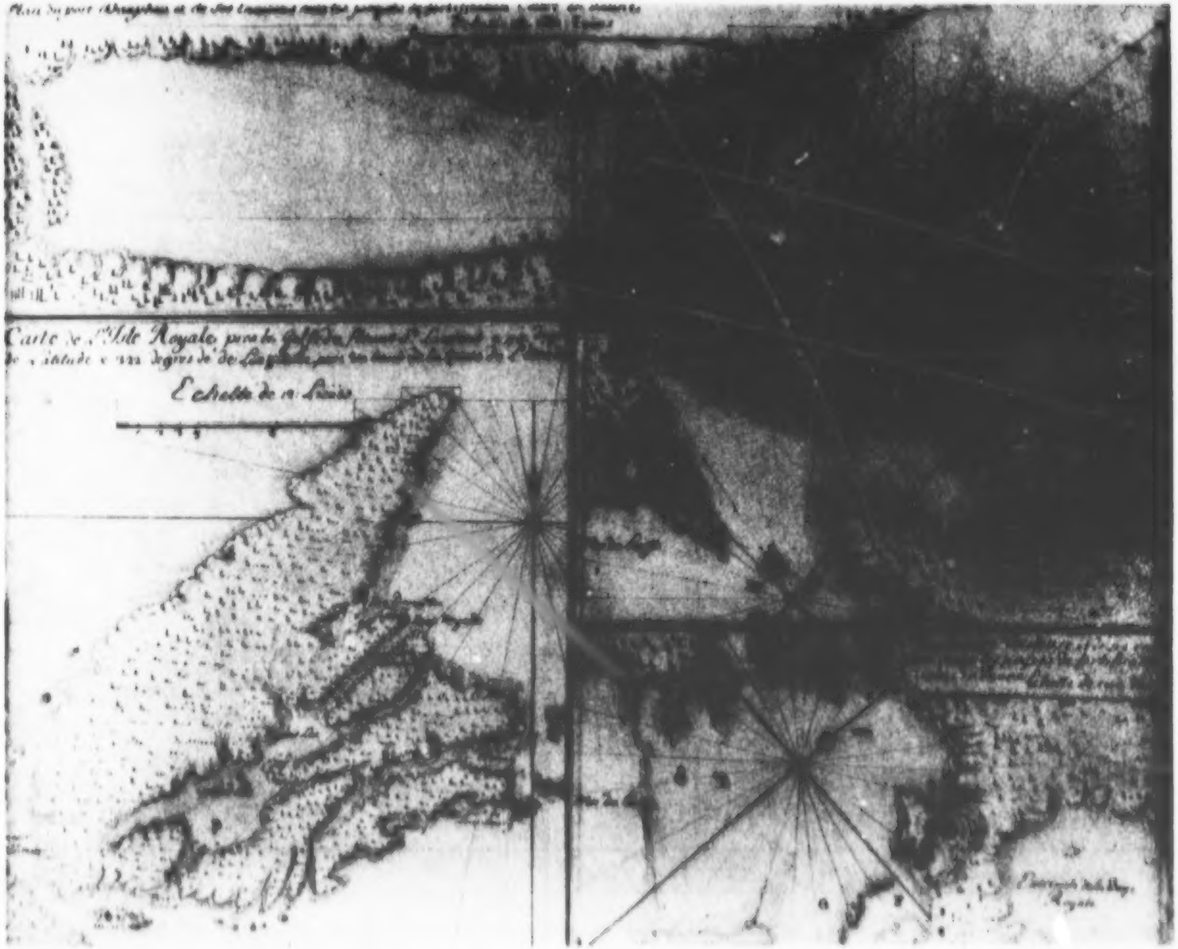
60 Montmédy. Traverses on the covered way to provide protection against enfilade, especially *tir à ricochet*, from the commanding ground beyond the ramparts. (Photo by author.)


QUEBEC
Gulf of
St. Lawrence
NEWFOUNDLAND
Quebec
NEW BRUNSWICK
P.E.I.
Placentia
Montreal
Louisbourg
USA
NOVA SCOTIA
Halifax
Boston
ATLANTIC OCEAN
0
200 miles
0
400 km

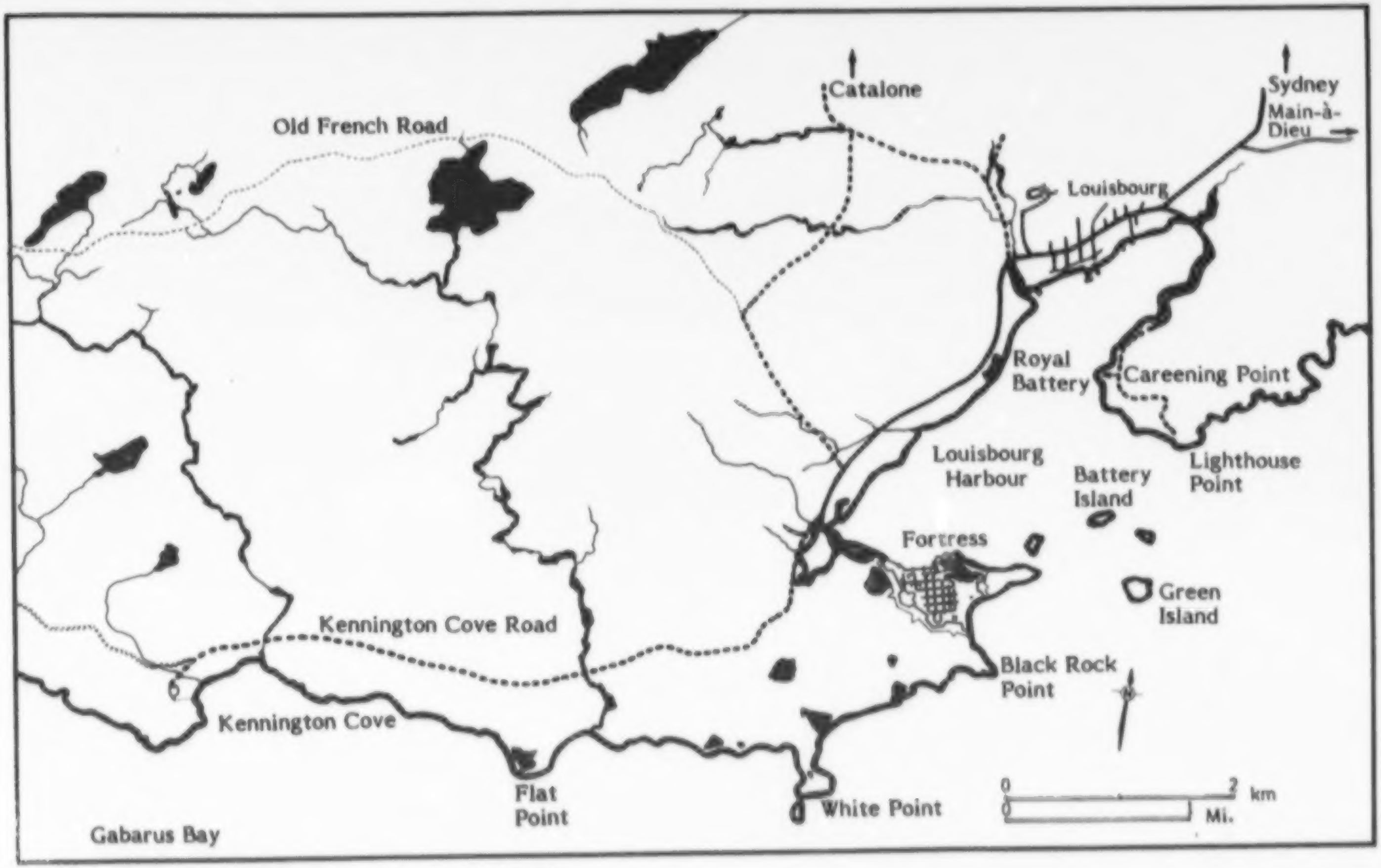
61 Eastern Canada and the Northeast United States. (Drawing by T.M. Smith.)

DE LA NOUVELLE FRANCE
OU DU CANADA

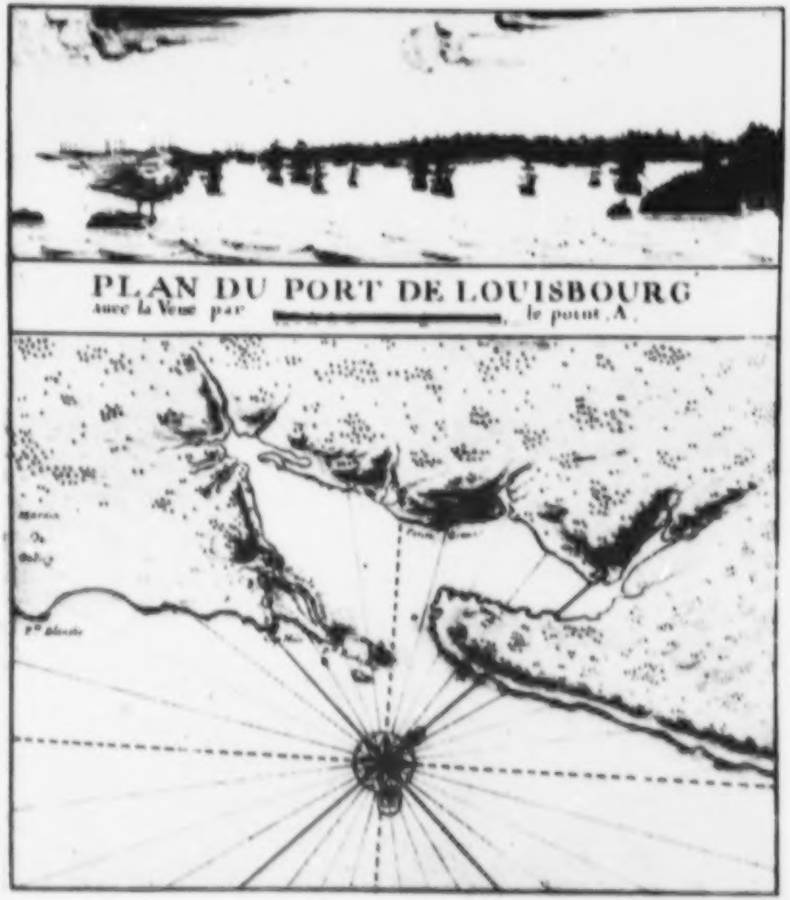
62 New France, 1744, the Gulf of St. Lawrence. The Acadian Peninsula and Cape Breton (Ile Royale) are located bottom centre. Principal fishing banks are also shown. (Public Archives Canada, H3/900.)



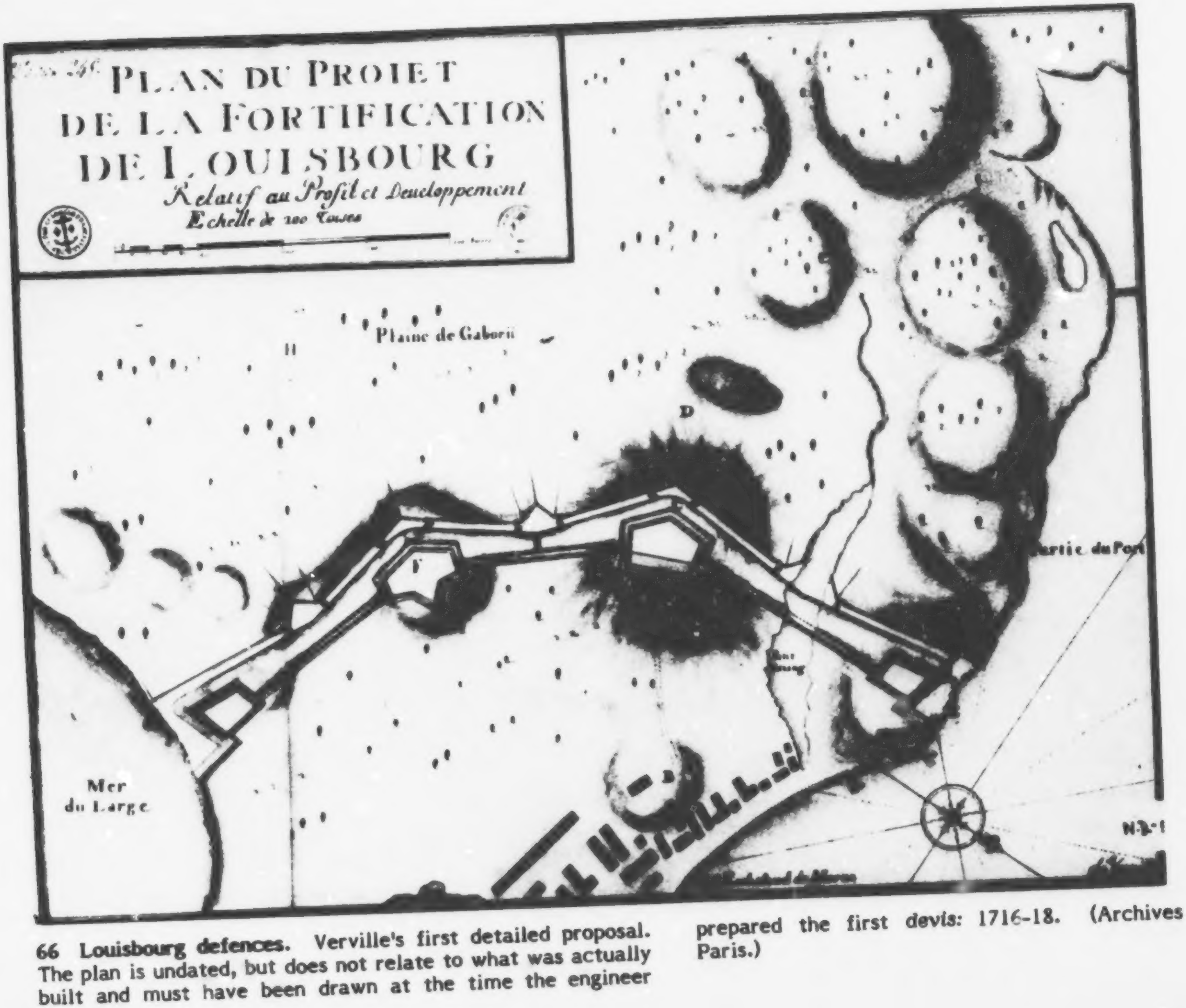
63 Ile Royale. Unsigned plan of 1717 accompanying Verville's report on his survey of the island. Proposals for fortifications at Port Dauphin (top), Louisbourg (centre) and Port Toulouse (bottom) are shown. (Archives du Génie, Vincennes.)


Old French Road
Catalone
Sydney
Main-à-Dieu
Louisbourg
Royal Battery
Careening Point
Louisbourg Harbour
Battery Island
Lighthouse Point
Fortress
Green Island
Kennington Cove Road
Black Rock Point
Kennington Cove
Flat Point
White Point
Gabarus Bay
0
2
km
0
Mi.

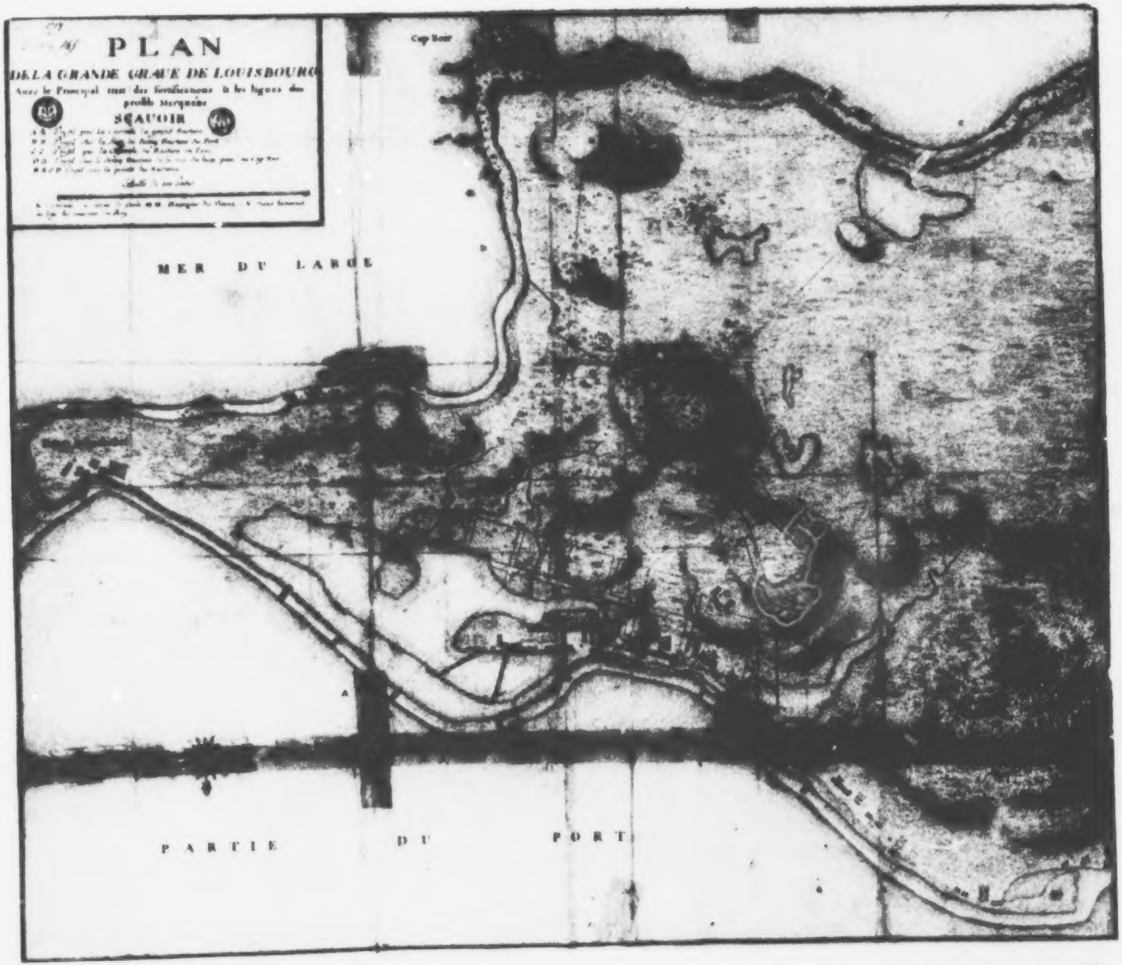
64 **Louisbourg and environs.** (Drawing by S. Epps.)


PLAN DU PORT DE LOUISBOURG
avec la Veue par le point A.

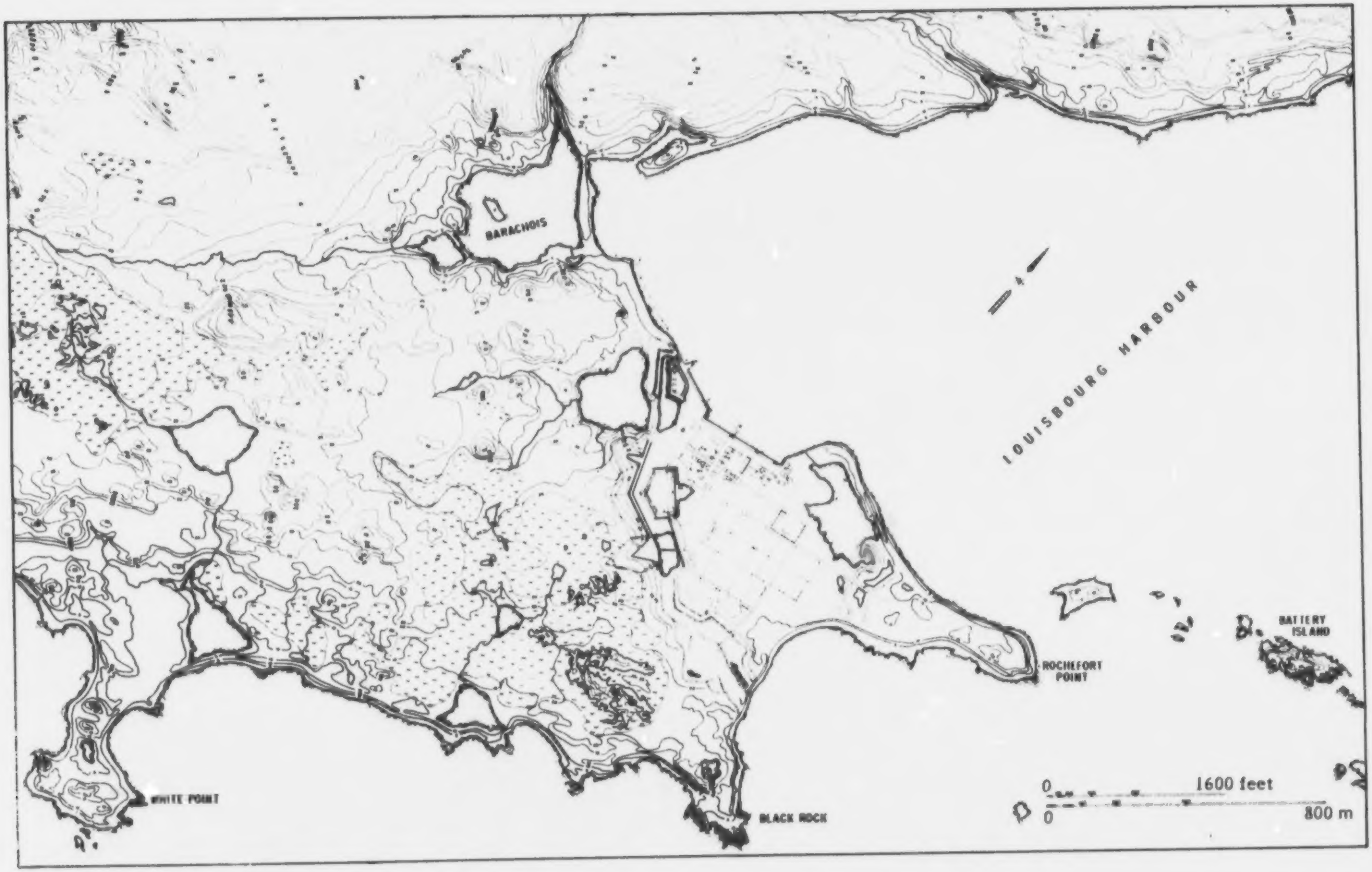
65 Louisbourg. One of the earliest proposals for defending the port. The plan is unsigned and undated, but the view above is virtually identical to one dated 1717 (BN, CP, SH, 131-11-2D). Location of the bastions and batteries is indicated by the posts on the shore and skyline. In plan, the central *redoute bastionnée* and the other landward defences are already represented. The crudely drawn plan is inaccurate in detail. (Bibliothèque Nationale, Paris.)


PLAN DU PROIET
DE LA FORTIFICATION
DE LOUISBOURG
Relatif au Profil et Developpement
Echelle de 200 Toises
Plaine de Gaborit
D
F
Partie du Port
Mer
du Large

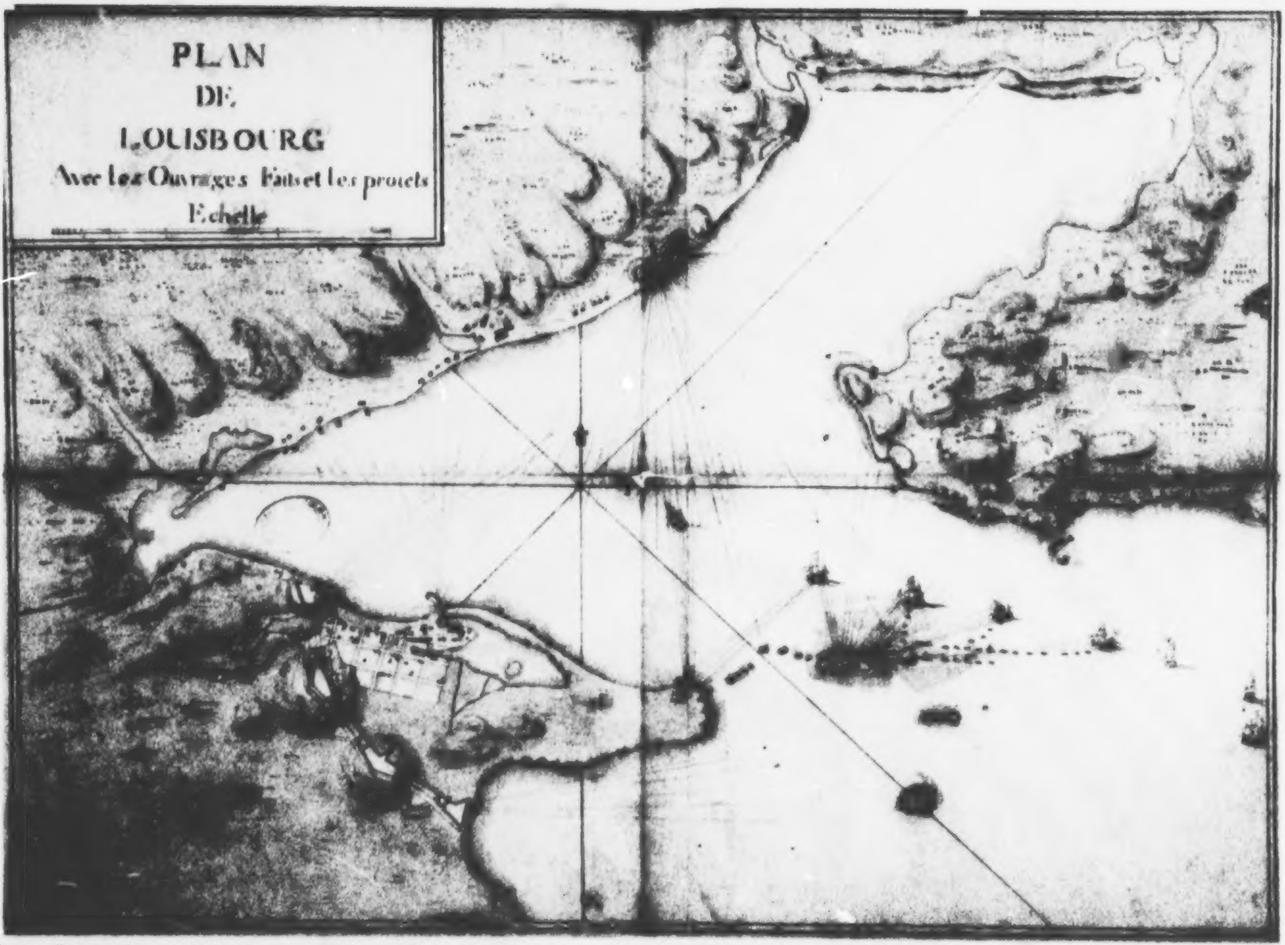
66 Louisbourg defences. Verville's first detailed proposal. The plan is undated, but does not relate to what was actually built and must have been drawn at the time the engineer prepared the first *devis:* 1716-18. (Archives Nationales, Paris.)


PLAN
DE LA GRANDE GRAVE DE LOUISBOURG
SÇAVOIR
Cap Noir
MER DU LARGE
PARTIE DU PORT

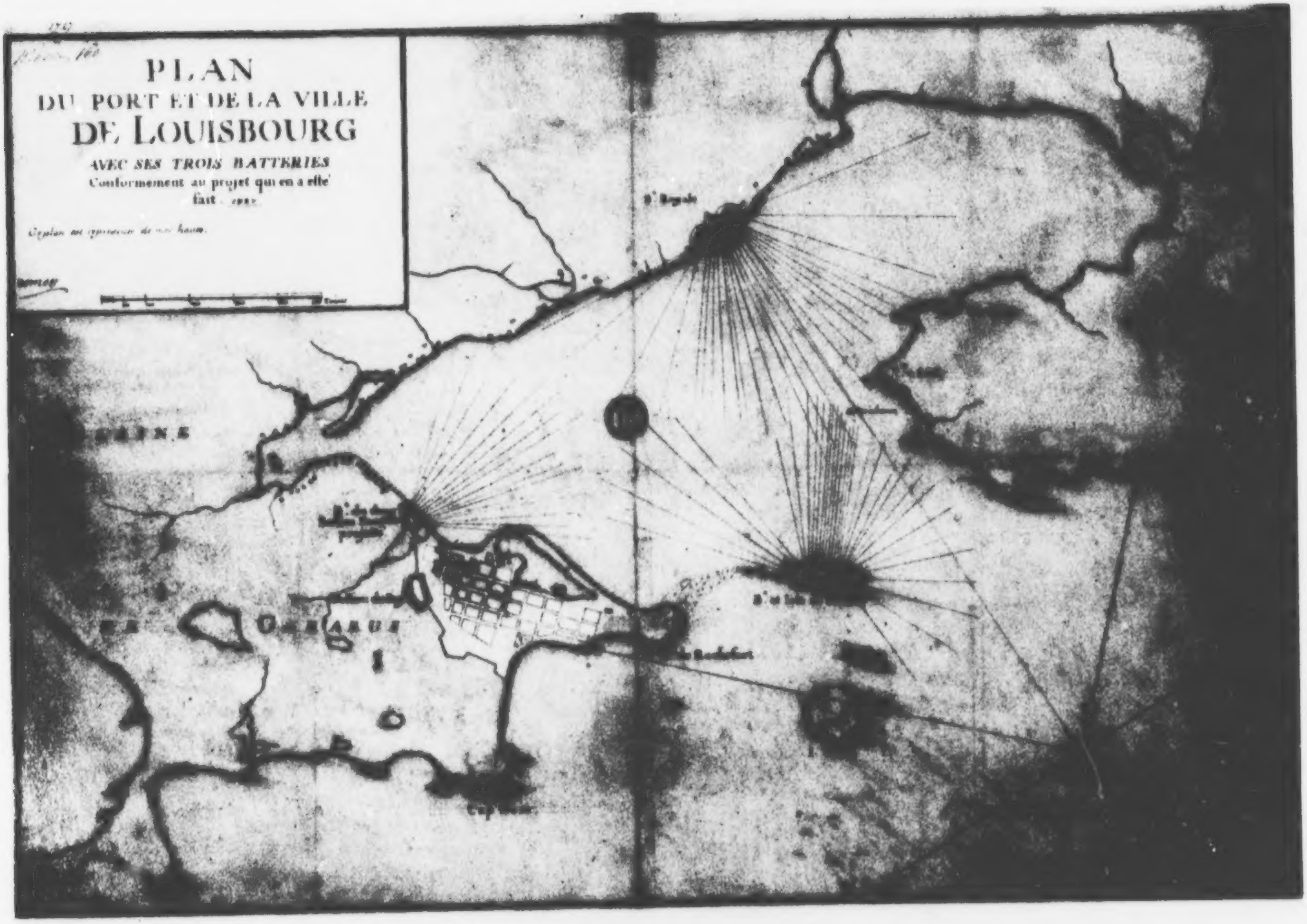
67 The first trace of the *enceinte* to which the bastions were built. The partial polygon from which the bastions were developed and the capitals of the two principal bastions are shown in fine lines. The draftsman was presumably Verville, although the plan is unsigned. (Archives Nationales, Paris.)


BARACHOIS
LOUISBOURG HARBOUR
ROCHEFORT POINT
BATTERY ISLAND
WHITE POINT
BLACK ROCK
0
1600 feet
0
800 m

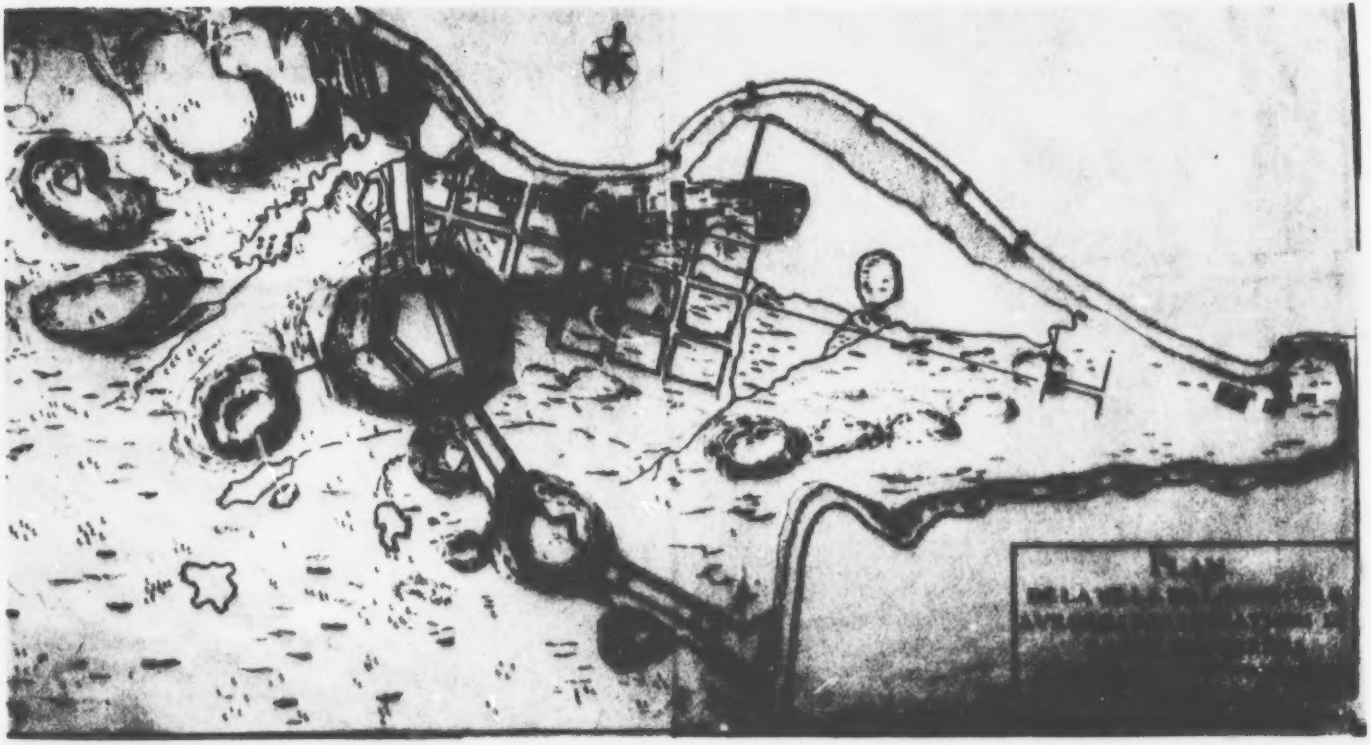
68 Fortress area contour plan. Five-foot contour intervals based on 1962 survey. (Drawing by T.M. Smith.)


PLAN
DE
LOUISBOURG
Avec les Ouvrages Faits et les projets
Echelle

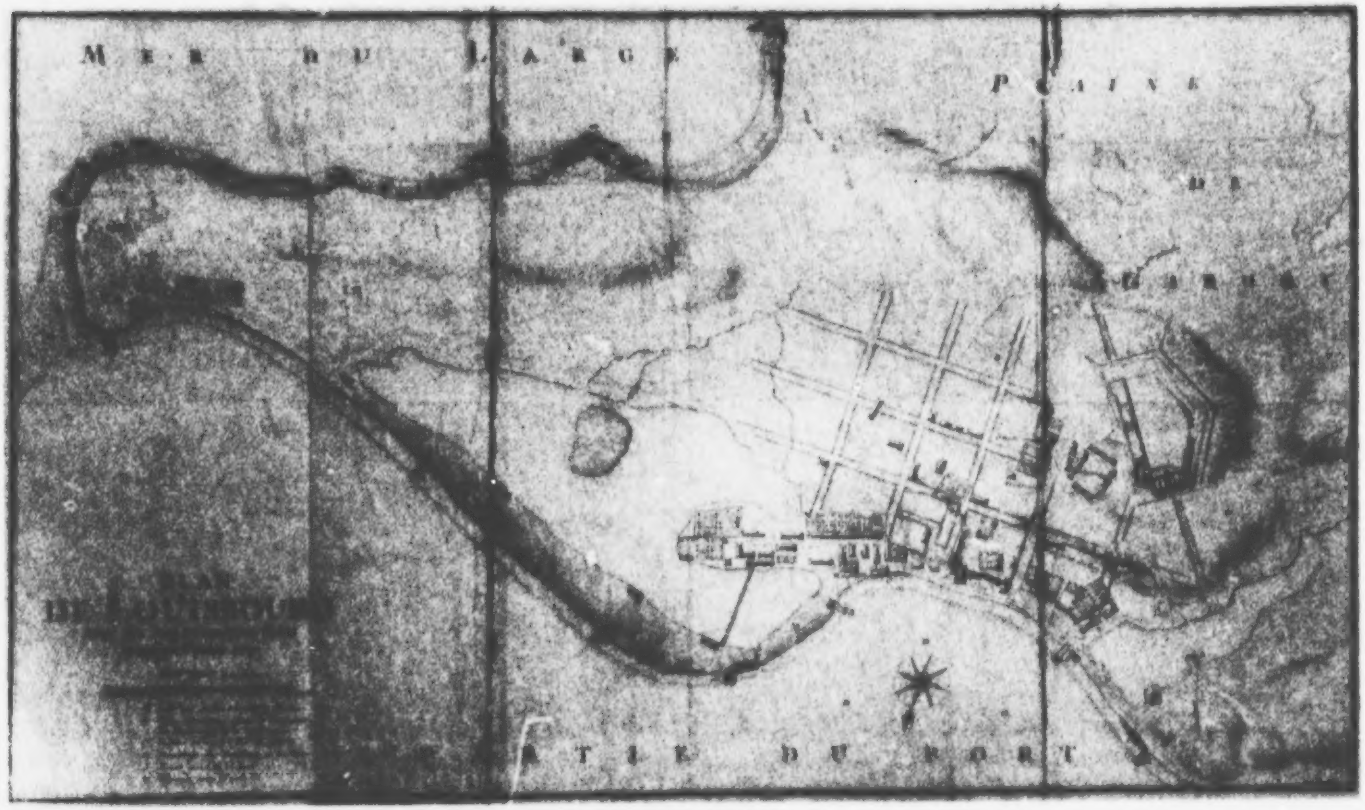
69 Harbour batteries. Initial proposals. The Royal and Island batteries are shown very much as built, but the others were modified or dropped. The plan is unsigned and undated, but as the right face and flank of the King's Bastion are shown as having been built, also a part of the barracks, a date of 1719-20 may be ascribed. (Archives Nationales, Paris.)


PLAN
DU PORT ET DE LA VILLE
DE LOUISBOURG
AVEC SES TROIS BATTERIES
Conformement au projet qui en a etté
fait

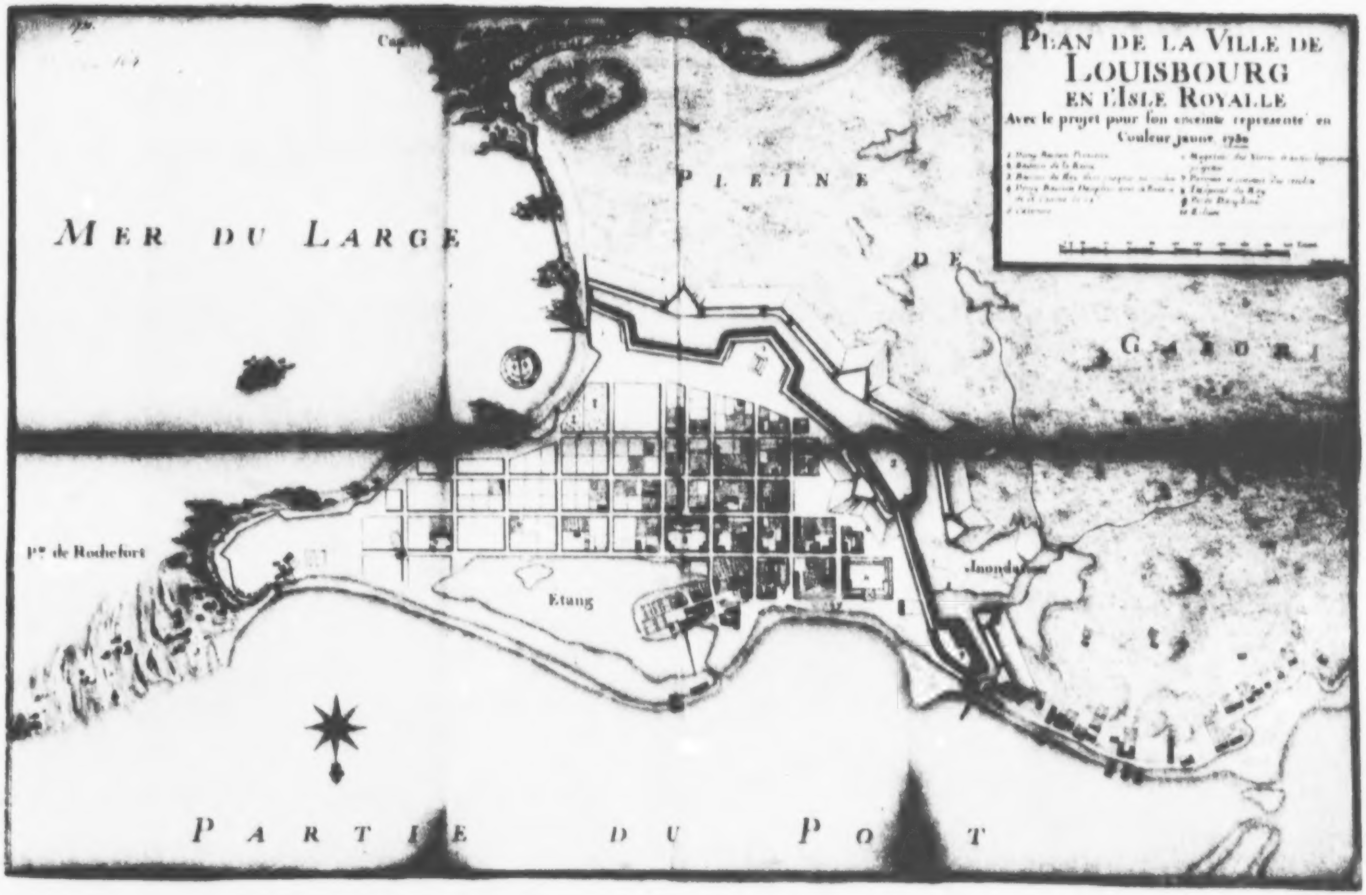
70 Harbour defences. Verrier's 1727 proposals, which were realized as shown, with the later addition of a fourth battery on the Pièce de la Grave. (Archives Nationales, Paris.)



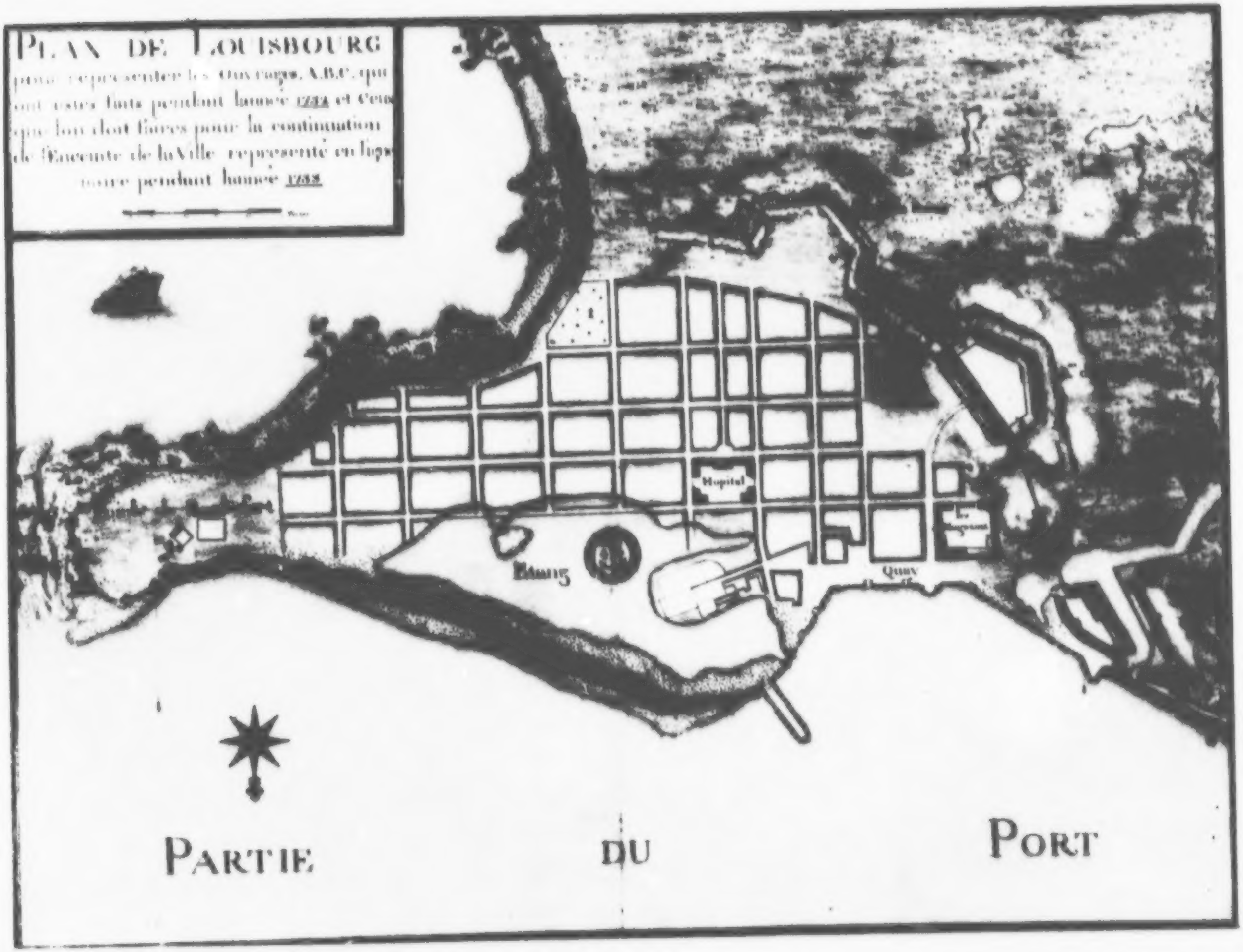
71 **Progress on the landward *enceinte*.** The King's Bastion is shown as it was actually built; the other bastions are still schematic proposals. The cruciform mine gallery on the capital line of the King's Bastion is already included in the plans. A triangular redoubt was proposed (but never built) for one of the hills opposite the King's-Dauphin curtain. Plan is undated and unsigned, but the construction already shown places it in the period 1719-20. (Bibliothèque Nationale, Paris.)



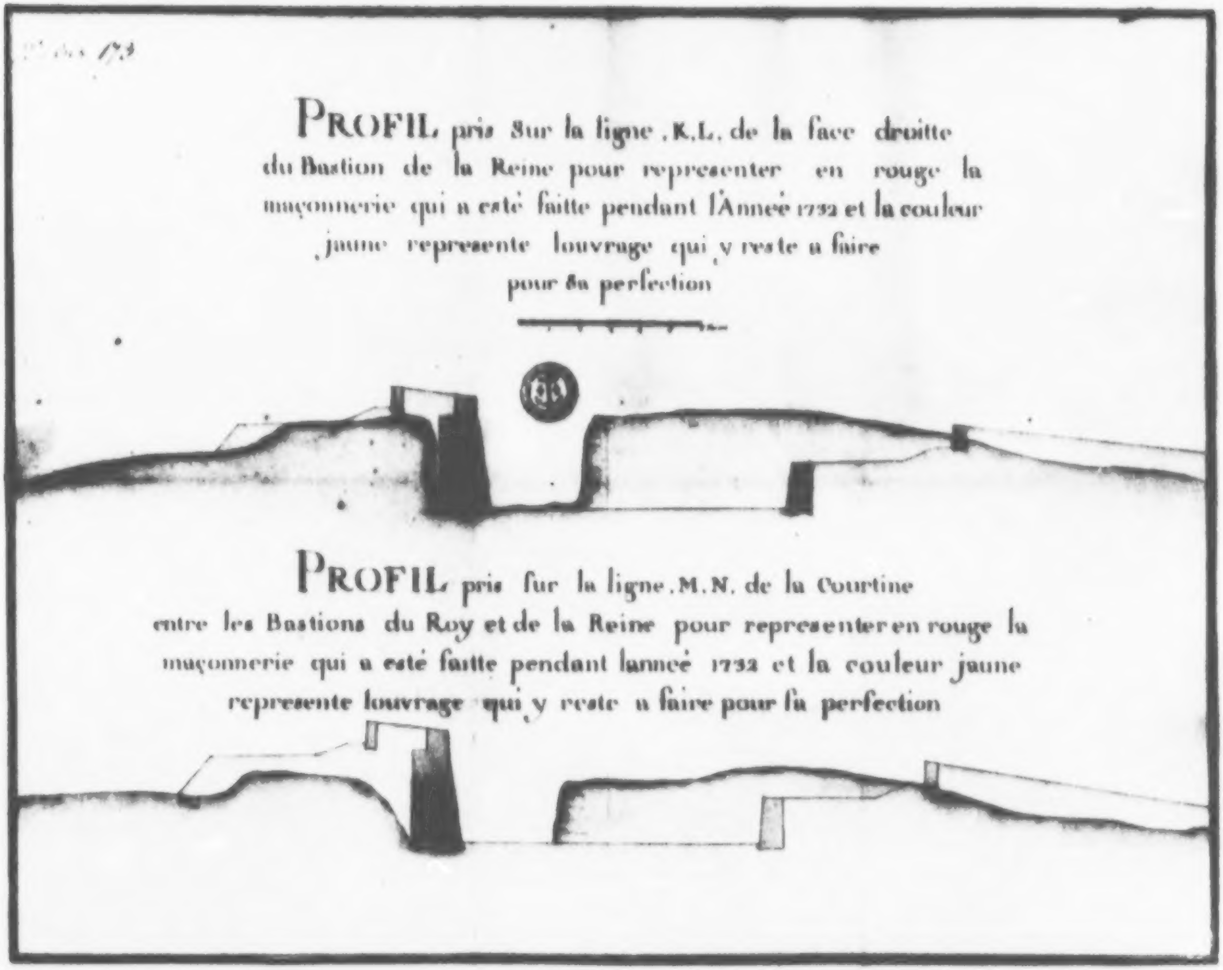
72 **Construction progress, 1720.** Boucher's plan shows the right flank and casemates of the King's Bastion as having been built, also the casemates along the right face and the north wing of the barracks. The plan is interesting for its depiction of the temporary government quarters and habitations, as well as the initial street layout of the town. (Archives du Génie, Paris.)


PLAN DE LA VILLE DE
LOUISBOURG
EN L'ISLE ROYALLE
Avec le projet pour son enceinte representé en
Couleur jaune. 1730
MER DU LARGE
PLEINE DE GABORI
Pte de Rochefort
Etang
Jaondadiere
PARTIE DU PORT

73 **Construction proposals.** Verrier's 1730 plan is particularly interesting for the defences envisaged extending from the Princess Bastion (depicted as a complete bastion, unlike the irregular work actually built) around Rochefort Point. The proposed curtain terminates in a battery on the point (Archives Nationales, Paris.)


PLAN DE LOUISBOURG
pour representer les Ouvrages A.B.C. qui
ont estes faits pendant lannée 1732 et Ceux
que lon doit faires pour la continuation
de l'Enceinte de la Ville representé en ligne
noire pendant lannée 1733
Hopital
Estang
Quay
PARTIE DU PORT

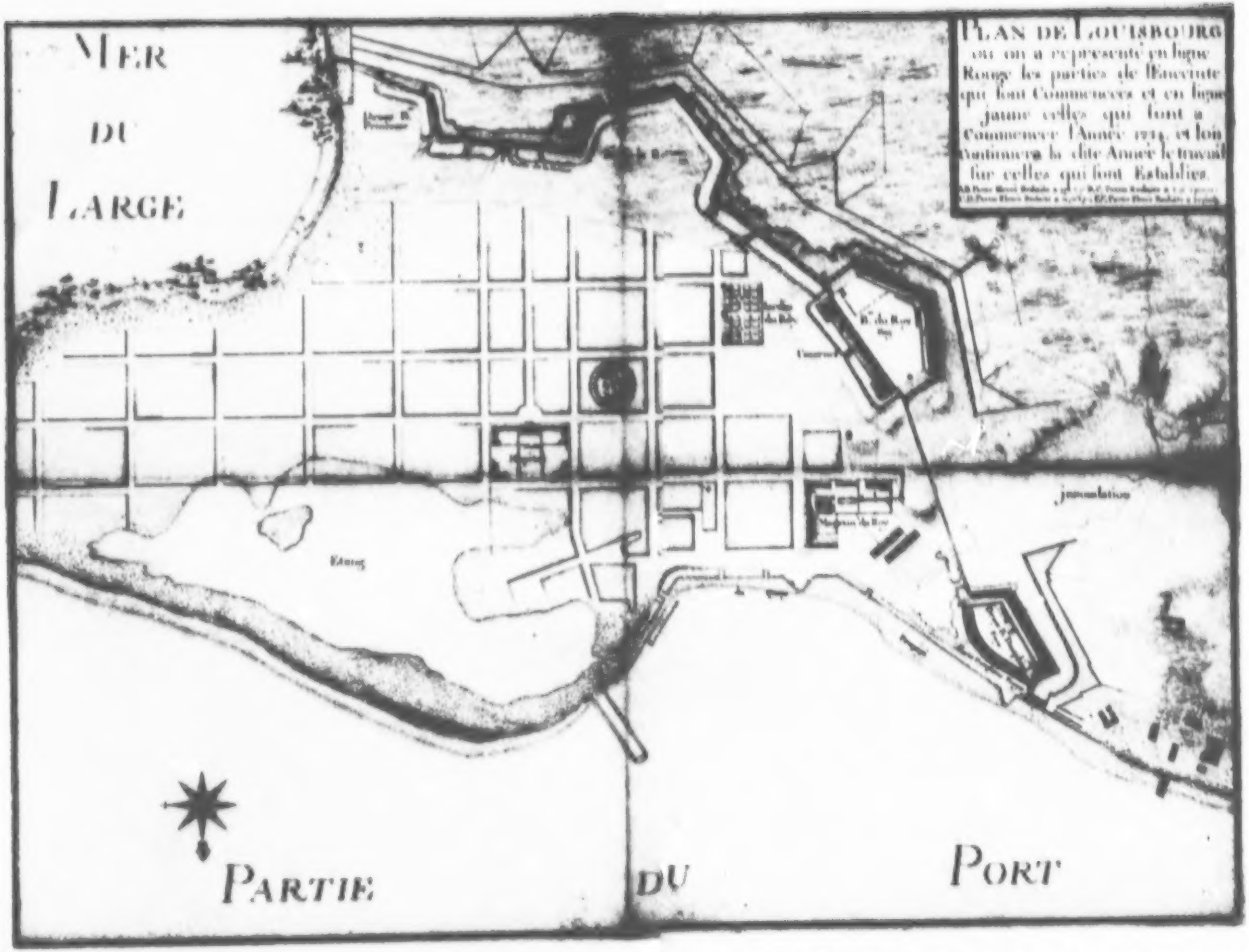
74 Construction progress, 1732. Excavation of the ditch in front of the King's and Queen's bastions and curtain is depicted. Note the proposed configuration of the quay, with two redans and a mole projecting from the gravel strand. (Archives Nationales, Paris.)



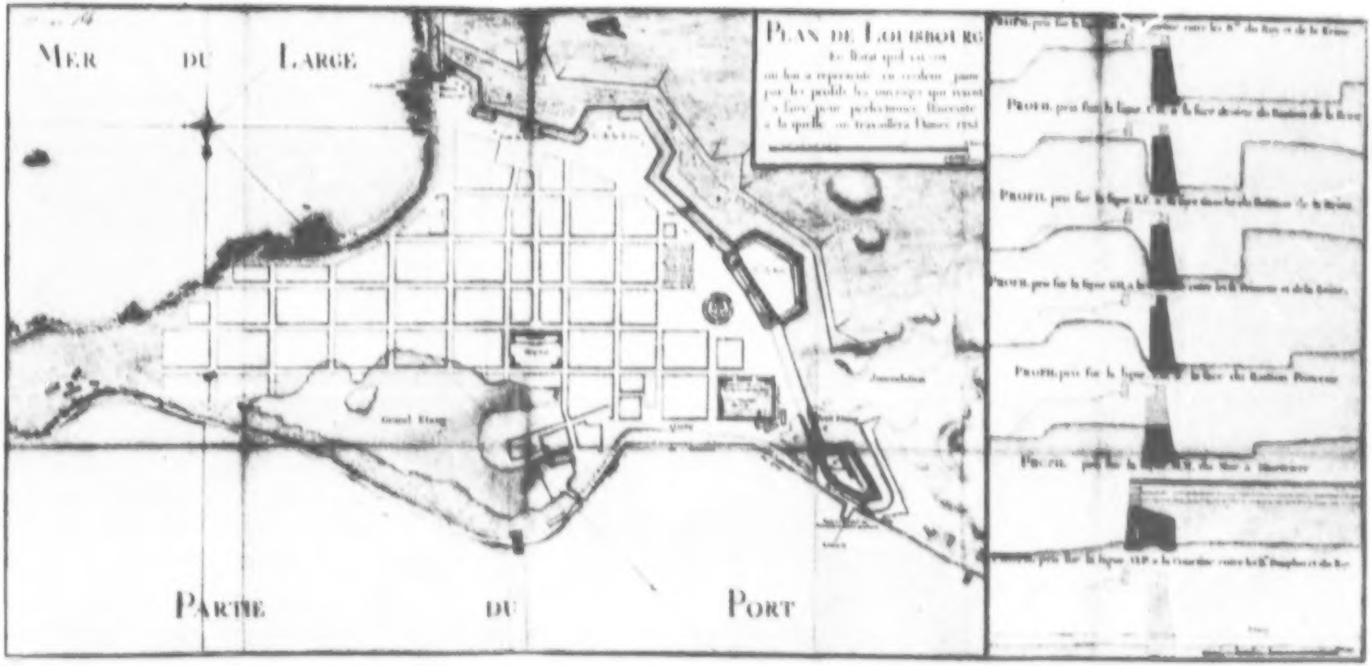
PROFIL pris Sur la ligne .K.L. de la face droitte
du Bastion de la Reine pour representer en rouge la
maçonnerie qui a esté faitte pendant l'Anneé 1732 et la couleur
jaune represente louvrage qui y reste a faire
pour Sa perfection

PROFIL pris ſur la ligne .M.N. de la Courtine
entre les Bastions du Roy et de la Reine pour representer en rouge la
maçonnerie qui a esté faitte pendant lanneé 1732 et la couleur jaune
represente louvrage qui y reste a faire pour ſa perfection

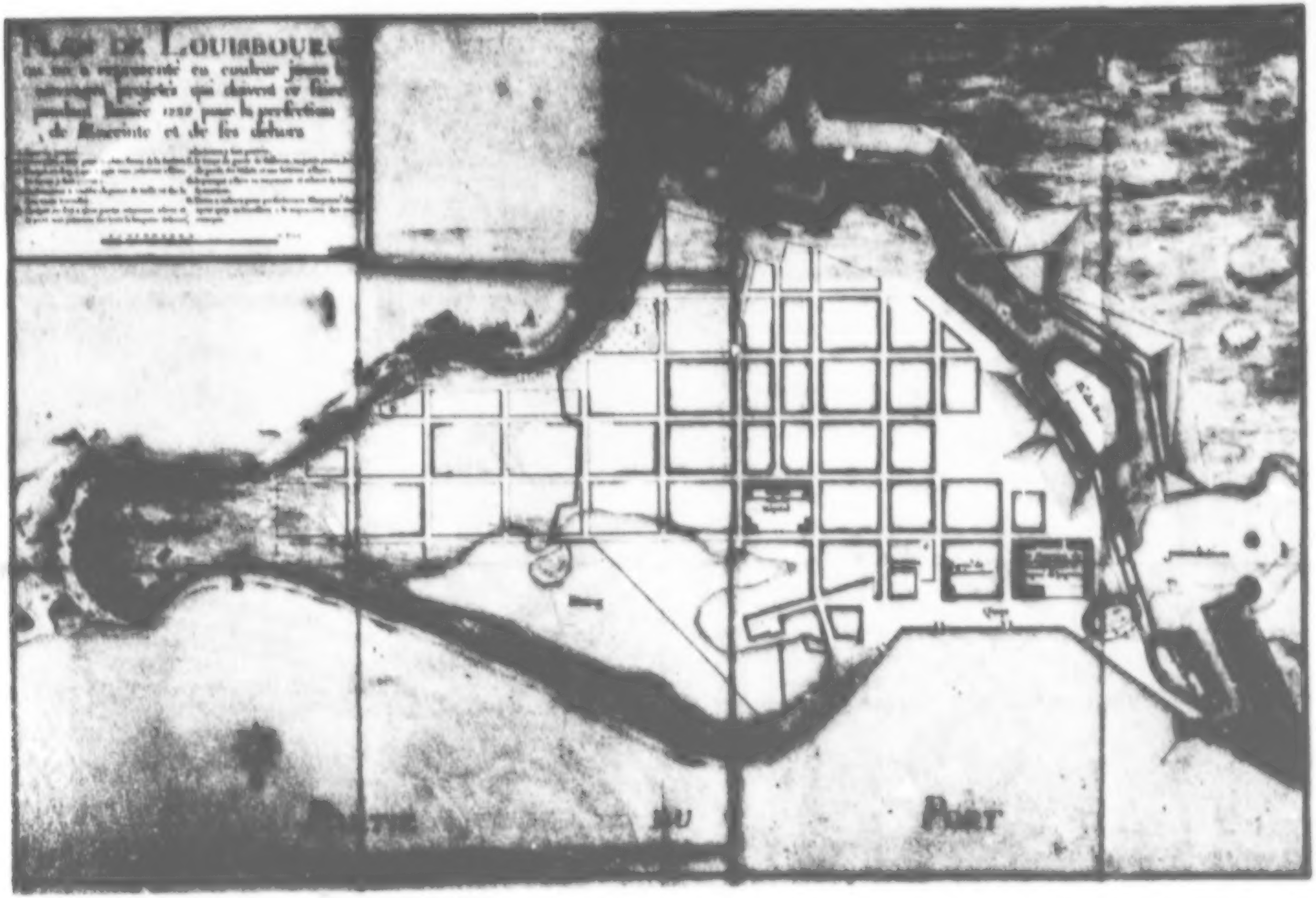
75 **Sections through the ramparts:** right face of Queen's Bastion, King's-Queen's curtain. The extent to which the ramparts make use of natural ground levels or rely on fill is depicted. (Archives Nationales, Paris.)


PLAN DE LOUISBOURG
où on a representé en ligne
Rouge les parties de l'Enceinte
qui ſont Commencées et en ligne
jaune celles qui ſont a
Commencer l'Année 1734, et l'on
continuera la dite Année le travail
ſur celles qui ſont Establies.
MER DU LARGE
B. du Roy
Magasin du Roy
Etang
jnondation
PARTIE DU PORT

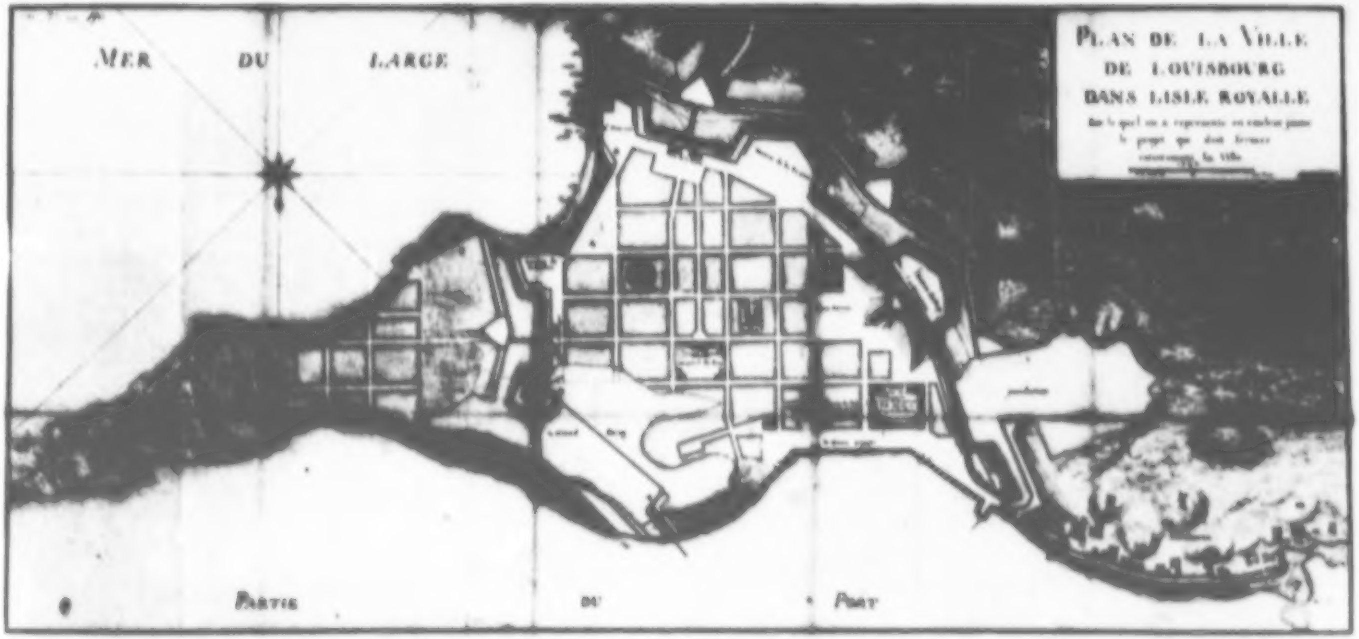
76 Construction progress, 1733. The ditch from the King's to the Princess Bastion is well under way. Note that the Princess Bastion is depicted as a foreshortened half-bastion, as it was to be built. (Archives Nationales, Paris.)


MER DU LARGE
PLAN DE LOUISBOURG
Grand Etang
PARTIE DU PORT

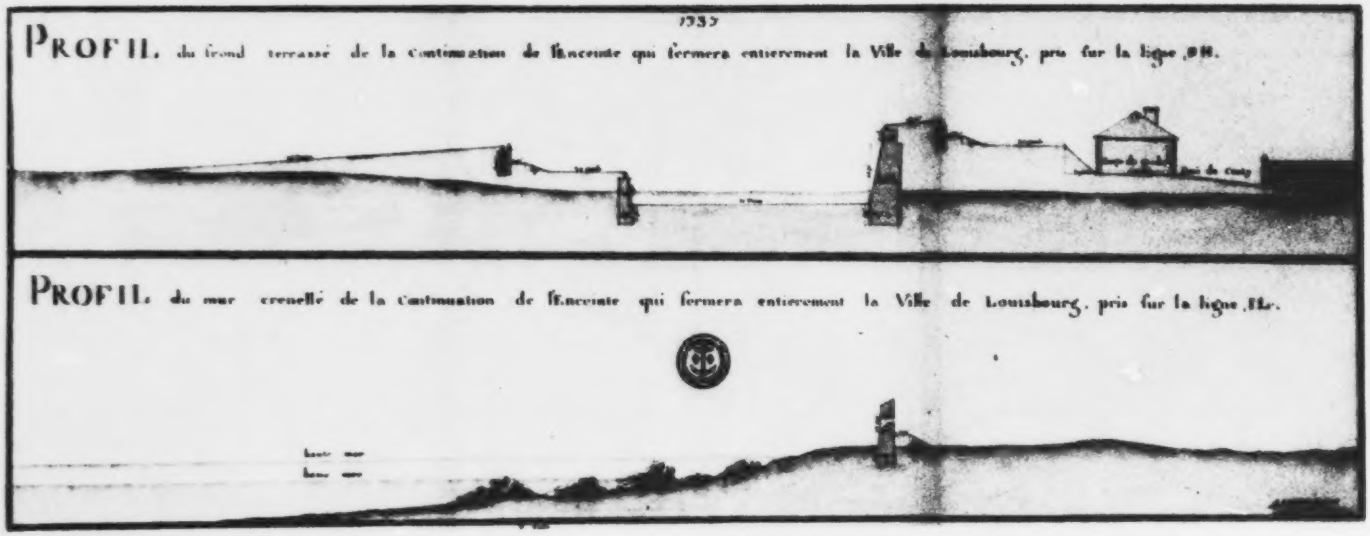
77 Construction progress, Verrier, 1734. The plan is of interest principally because of the accompanying sections. Note, in particular, section MN (second from bottom), through the loopholed wall of the Princess Bastion, and the modified project of the quay, with the *éperon* in front of the Dauphin Bastion. (Archives Nationales, Paris.)



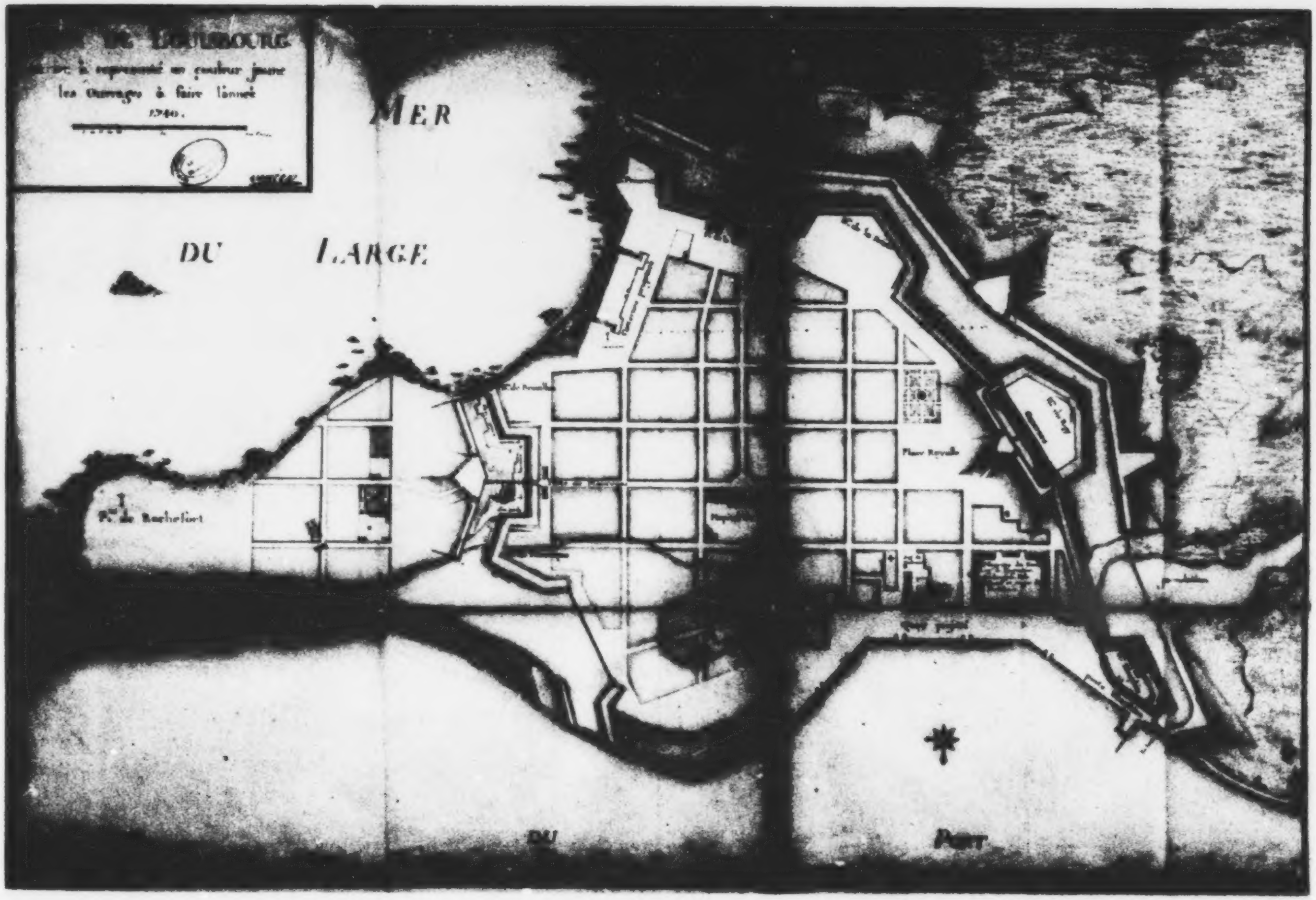
78 Construction proposals, Verrier, 1737. A new, bastioned *enceinte* to isolate the town from Rochefort Point is indicated for the first time. Note also the *éperon* covering the shallows in front of the Princess Bastion. (Archives Nationales, Paris.)


MER
DU
LARGE
PLAN DE LA VILLE
DE LOUISBOURG
DANS LISLE ROYALLE
PARTIE
DU
PORT

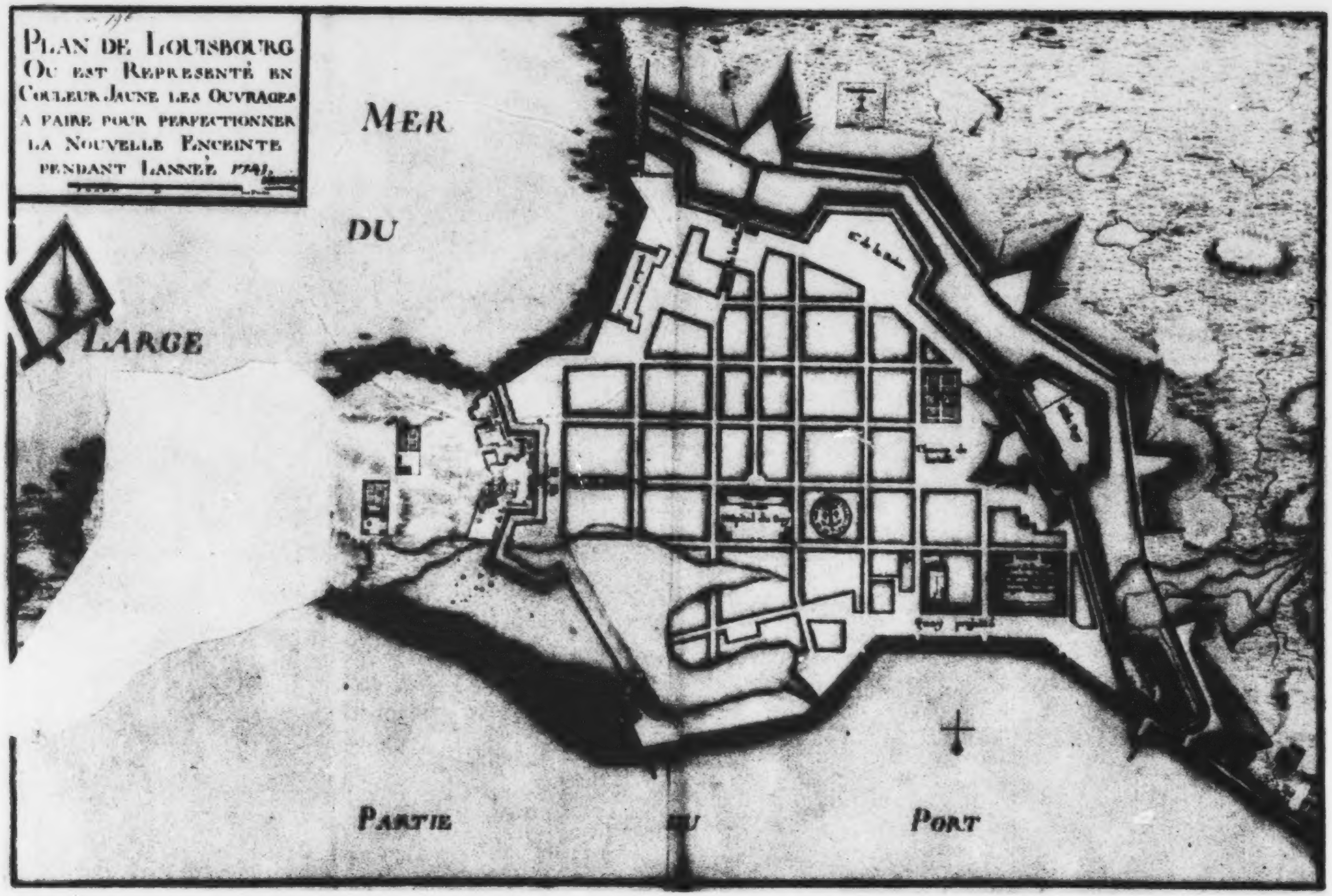
79 Construction proposals, Verrier, 1737. Modifications to the proposed new fortifications at Rochefort are apparent when compared with the preceding plan. Note also the battery proposed for the gravel strand at the end of the quay (Pièce de la Grave). (Archives Nationales, Paris.)


1737
PROFIL du front terrassé de la continuation de l'Enceinte qui fermera entierement la Ville de Louisbourg, pris sur la ligne ,OH.
PROFIL du mur crenellé de la continuation de l'Enceinte qui fermera entierement la Ville de Louisbourg, pris sur la ligne ,IL.
haute mer
basse mer

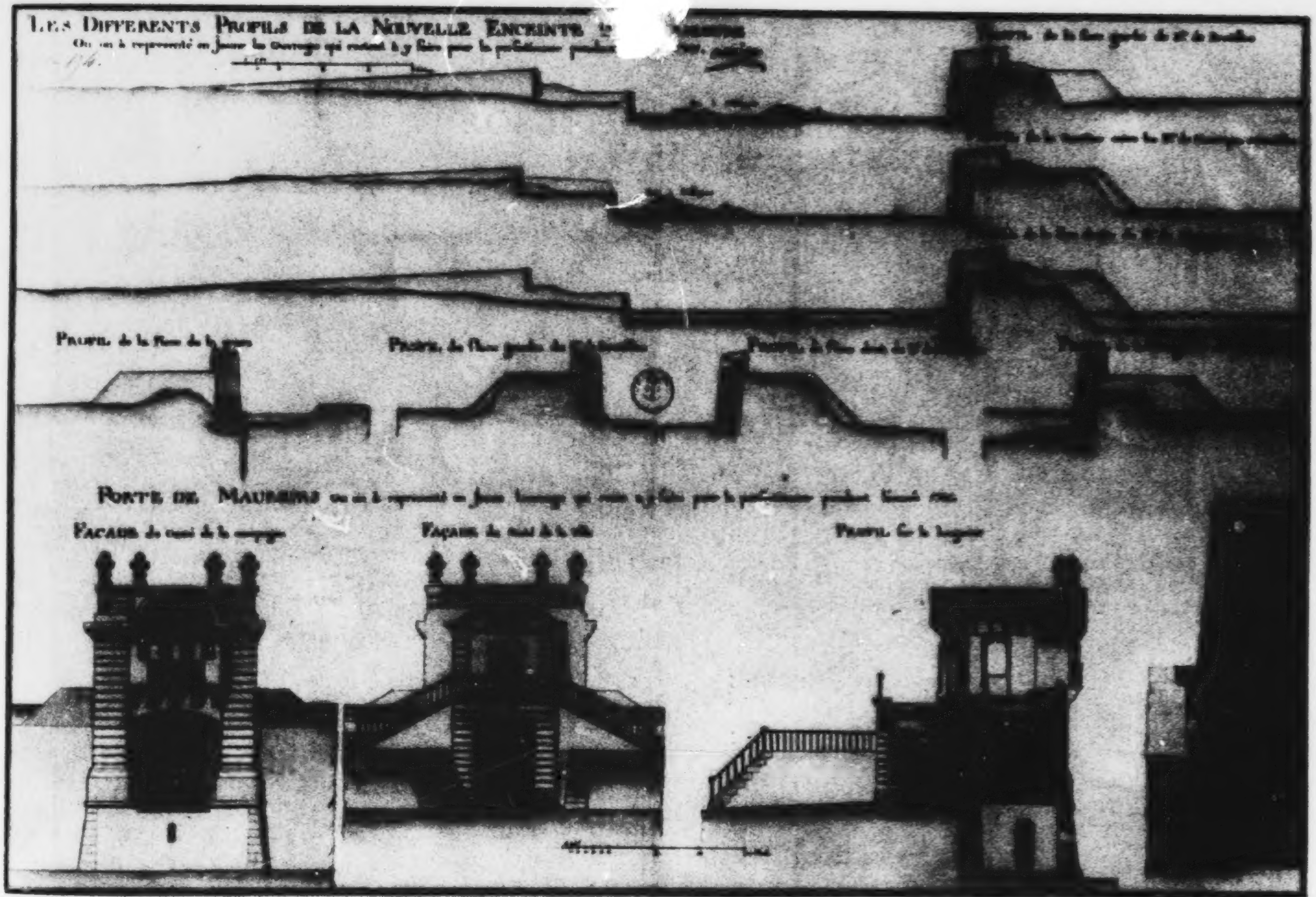
80 Construction proposals, Verrier, 1737. Profiles through the new fortifications (locations are indicated on preceding plan). (Archives Nationales, Paris.)


DE LOUISBOURG
à representé en couleur jaune
les Ouvrages à faire l'année
1740.
MER
DU
LARGE
Place Royalle
DU
PORT

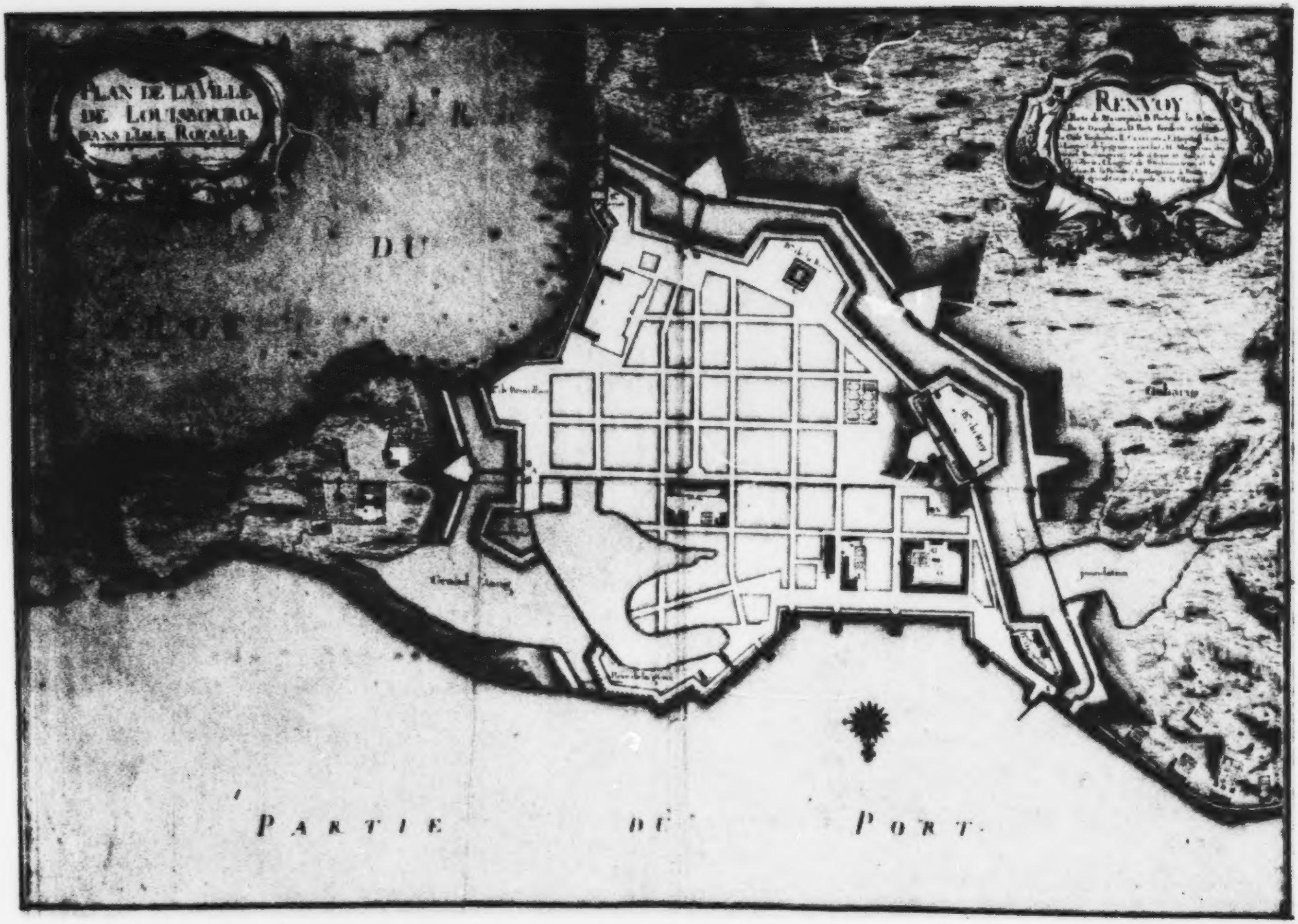
81 1740 construction proposals, Verrier, 1739. Work is progressing on the new fortifications and *mur crenelé* between the Brouillan and Princess bastions; a new barracks is proposed (never realized) behind this wall. On the landward *enceinte*, the outworks are nearing completion. The rounded *place d'armes* off the right shoulder of the King's Bastion is depicted for the first time. (Archives Nationales, Paris.)


Plan de Louisbourg
Ou est Representé en
Couleur Jaune les Ouvrages
a faire pour perfectionner
la Nouvelle Enceinte
pendant lannée 1741.
Mer
du
Large
Partie
du
Port

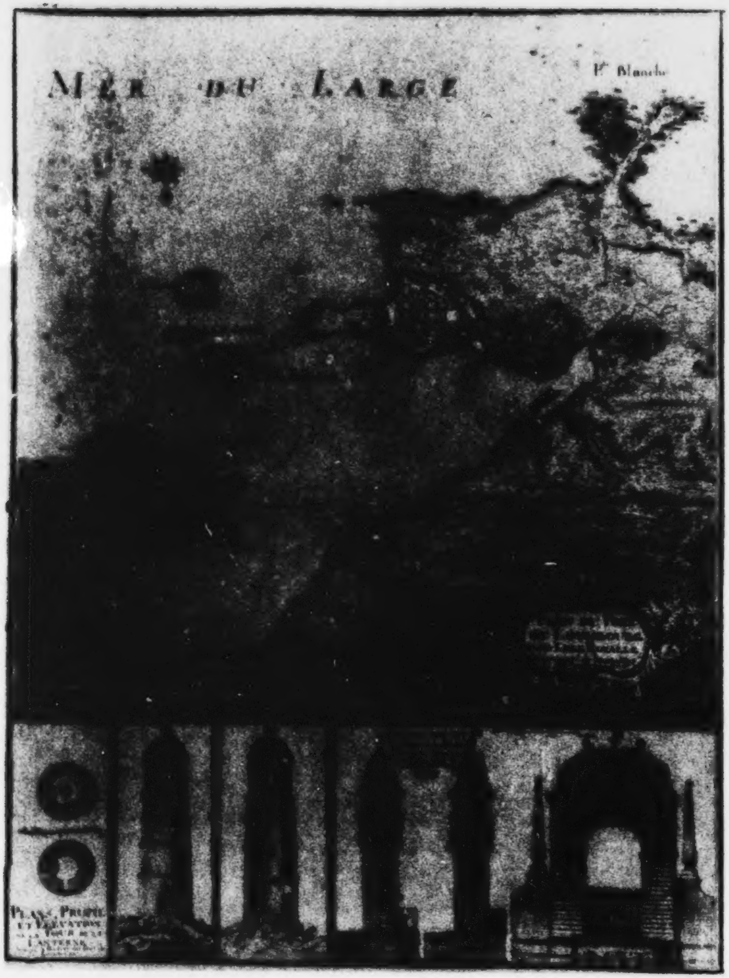
82 1741 construction proposals, Verrier, 1741. The new fortifications are virtually complete as far as the Pièce de la Grave; the ditch and outworks remain (when closed, a fold-away flap depicts these as completed). The quay has yet to be started. (Archives Nationales, Paris.)


LES DIFFERENTS PROFILS DE LA NOUVELLE ENCEINTE
PORTE DE MAUREPAS
FAÇADE du costé de la campagne
FAÇADE du costé de la ville
PROFIL sur la longueur

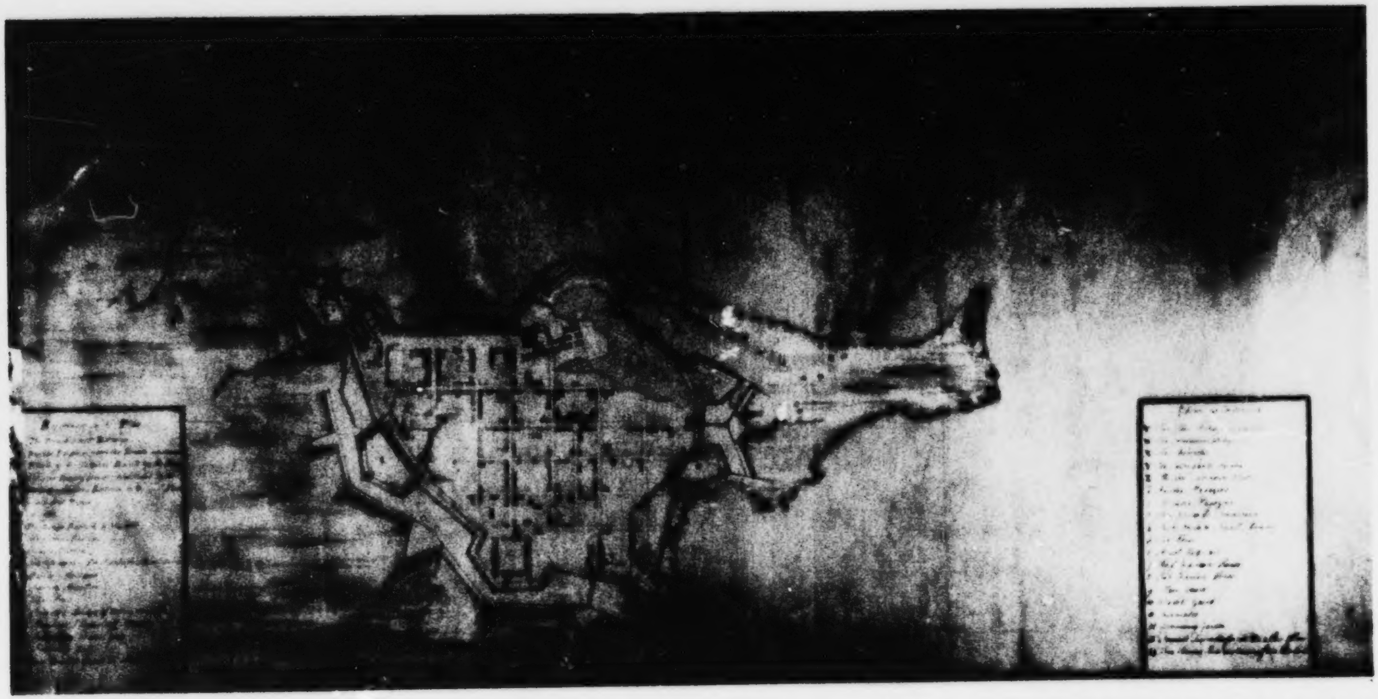
83 1741 construction proposals, Verrier. Profiles through the ramparts of the new fortifications indicate the sloping nature of the escarp and the revised form of parapets (cf. Fig. 80). Note also the timber cribwork on which the Pièce de la Grave escarp is founded. The revised design of the Maurepas Gate is presented. (Archives Nationales, Paris.)


PLAN DE LA VILLE DE LOUISBOURG DANS L'ISLE ROYALLE
RENVOY
DU
PARTIE DU PORT

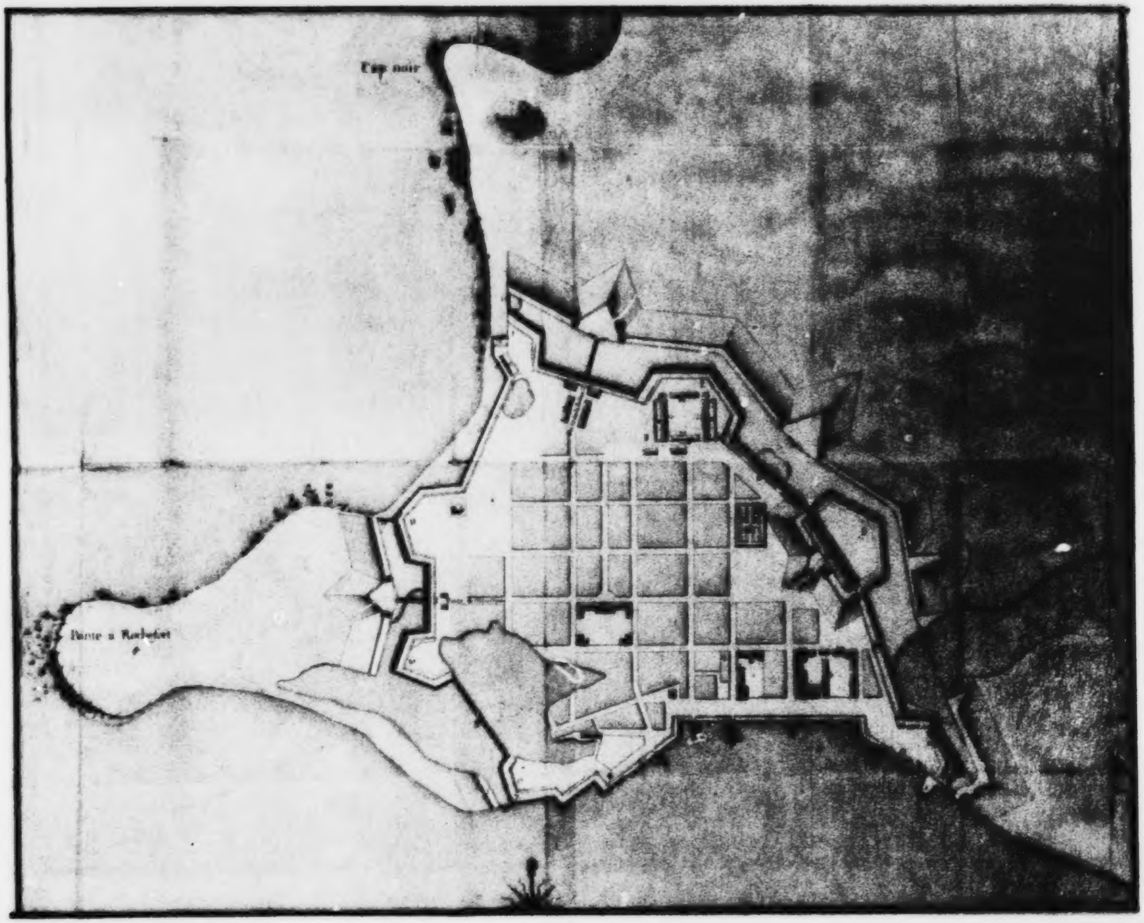
84 Louisbourg fortified, Verrier, 1744. The powder magazine, L, in the Queen's Bastion and the barracks, E, between the Princess and Brouillon bastions are proposals, but the rest of the fortifications are as built. (Archives du Génie, Vincennes.)


MER DU LARGE
Pte Blanche

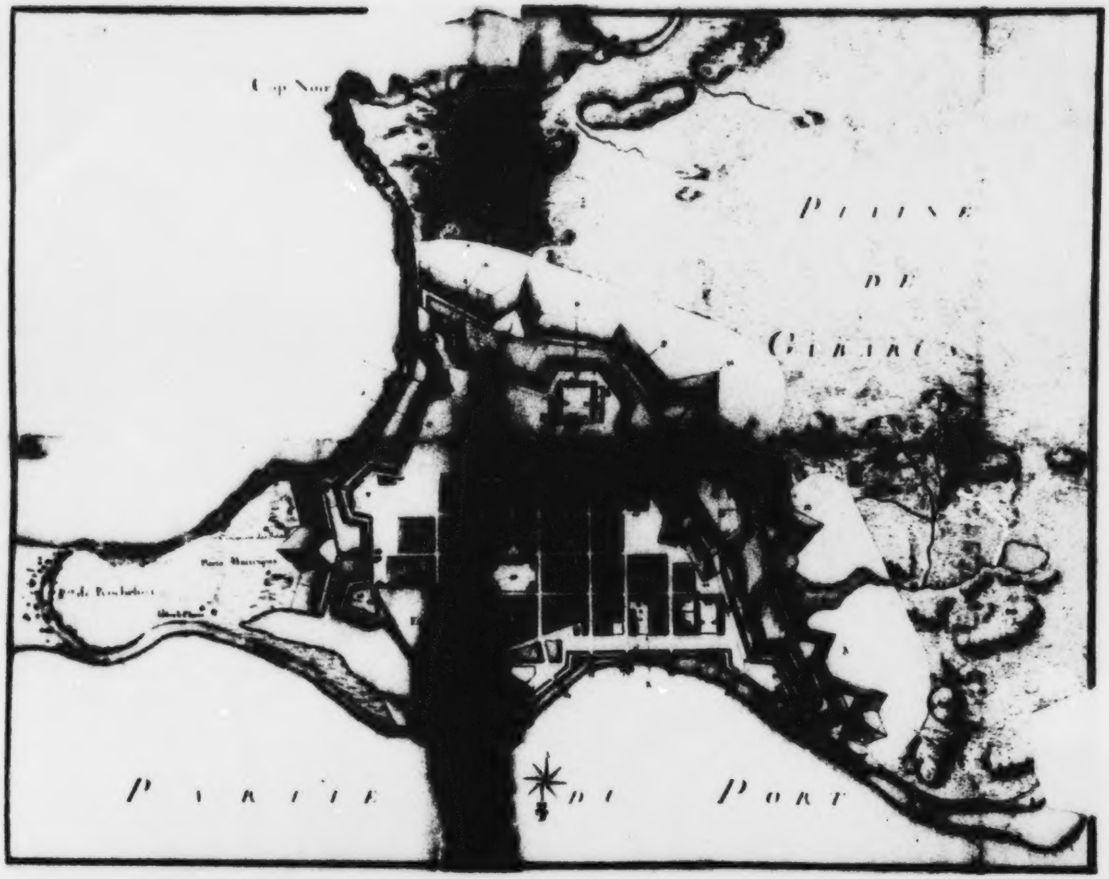
85 Harbour defences, 1742. The interrelated fields of fire from the four batteries are shown. Inset below are details on the lighthouse and Frederick Gate. (Archives du Génie, Vincennes.)



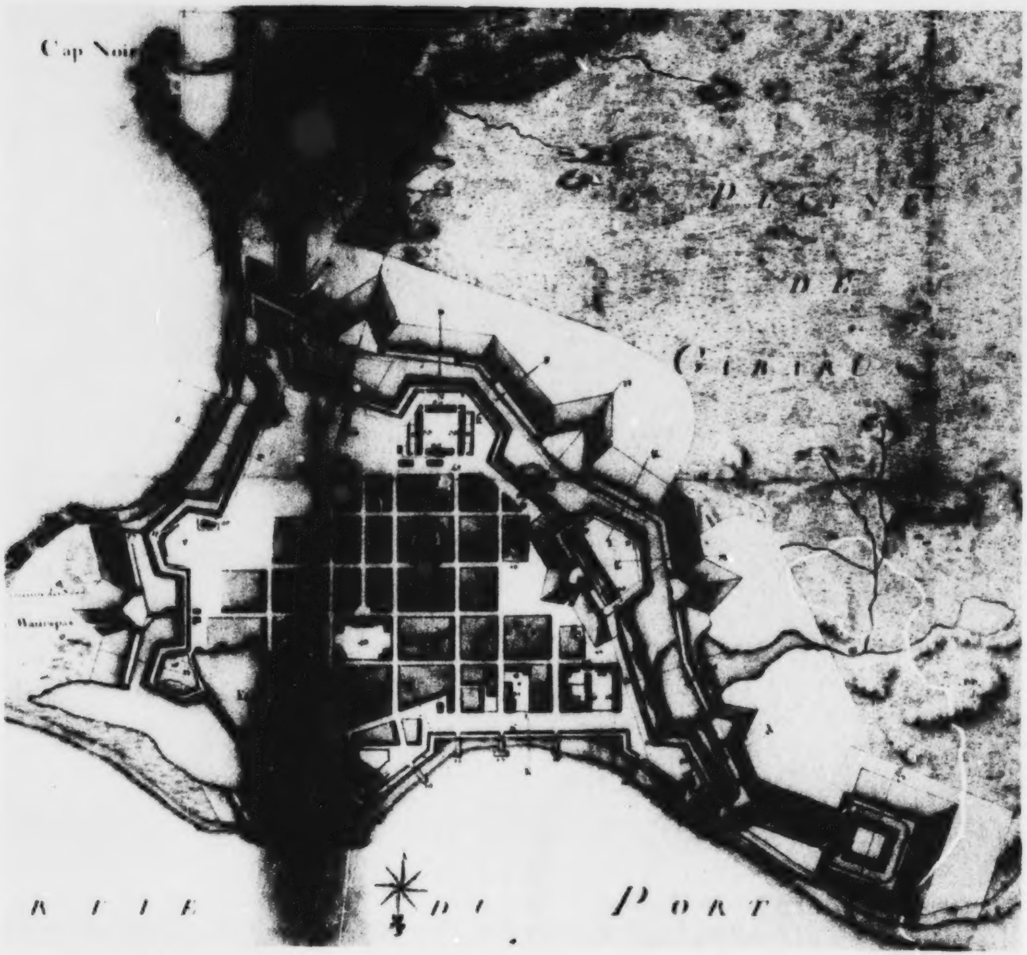
86 **The British occupation;** John Henry Bastide, 1745. The engineer has included proposals for improving the design and defensive capabilities of the Dauphin and Princess bastions. (Royal United Services Institution, London.)



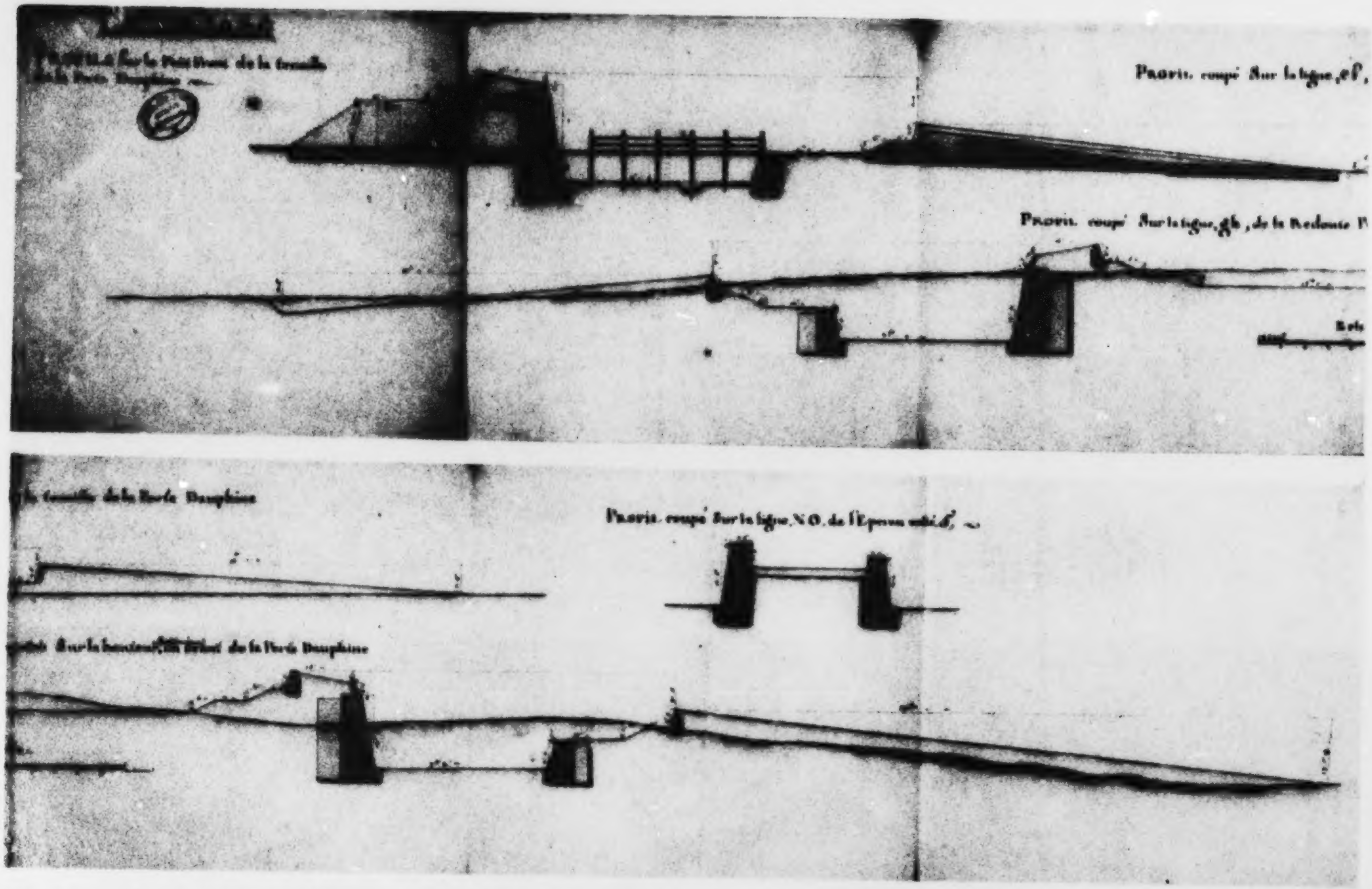
87 The fortifications, 1751. Plan accompanying Franquet's general description of the place as he found it (AG, CTG, 14-1-28). What is depicted is presumably the state of the fortifications as the British had left them in 1749. Note the embrasures on the right face of the King's Bastion and the left face of the Dauphin Bastion, also on the intervening curtain. (Archives du Génie, Vincennes.)



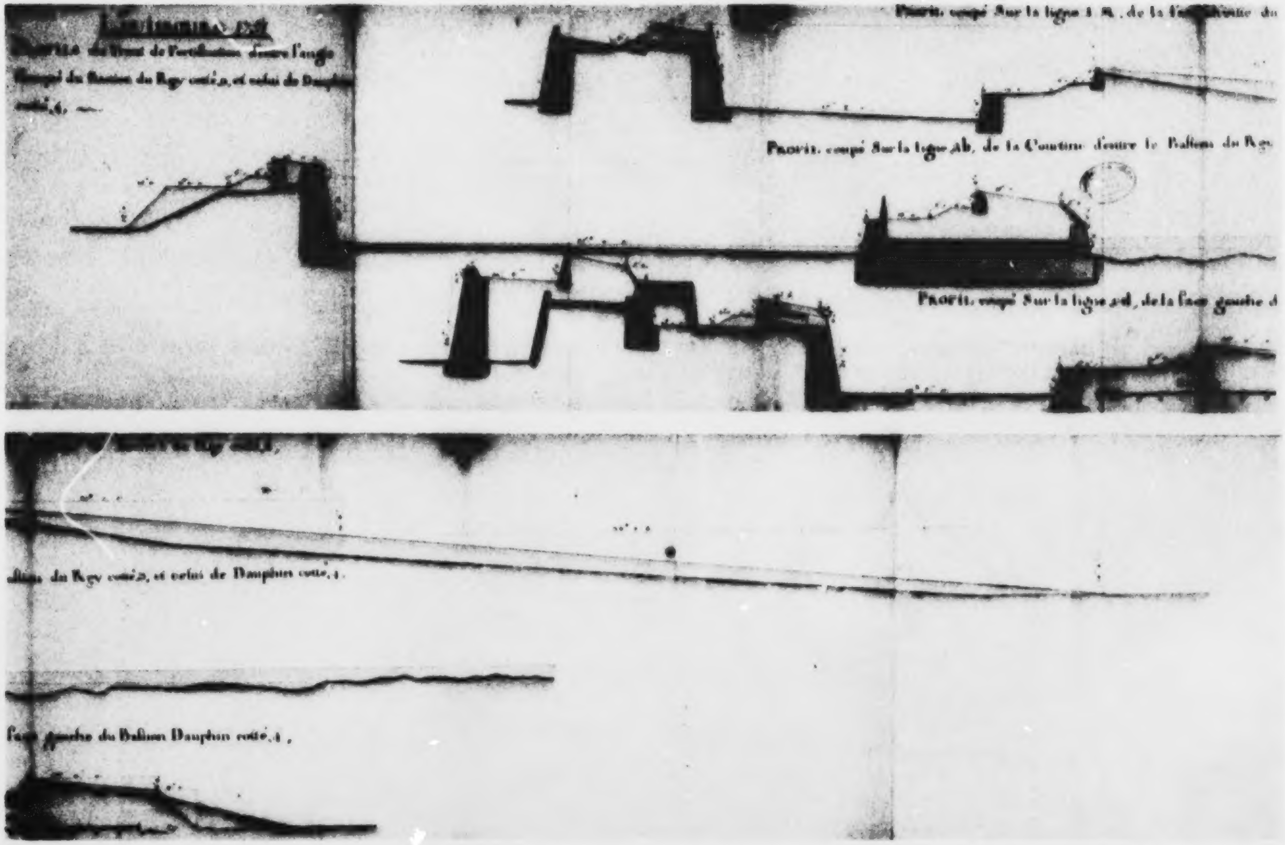
88 Proposals to improve the fortifications, Franquet, 1751. The plans show what the engineer considered to be a strict minimum of work in order to maintain a good defence. The major modifications are to the outworks on the King's-Dauphin front: the covered way, with large *place d'armes*, is continued across the pond and a second glacis, flanked by two more *places d'armes*, extends the capital line of the Dauphin Bastion towards the lime-kiln hill (AA, circled). The curtain on this front is provided with embrasures and a series of traverses to protect the gunners from enfilade. (Archives Nationales, Paris.)



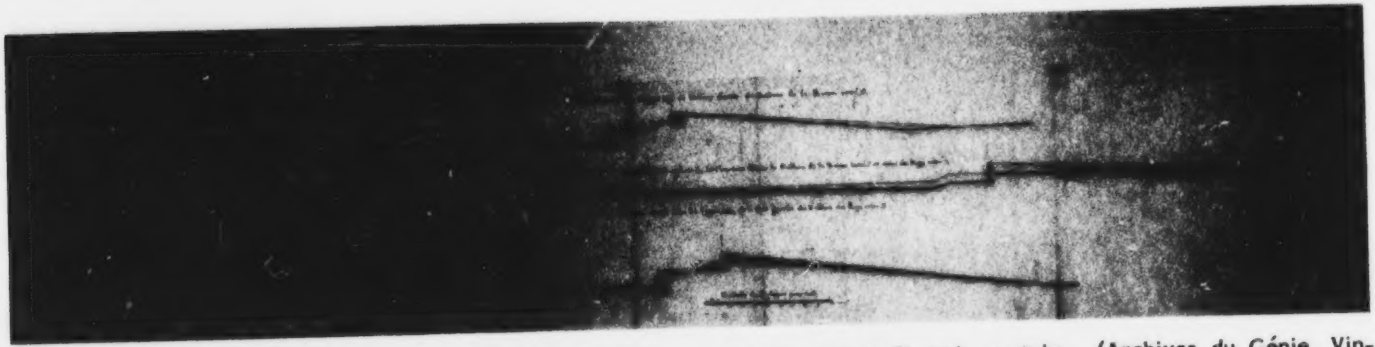
89 **Proposals to improve the fortifications,** Franquet, 1751. The same plan as in Figure 88, but with foldaway flaps down to indicate the location and design of the proposed redoubts at Black Rock and on the lime-kiln hill. (Archives Nationales, Paris.)


Profil. coupé Sur la ligne, ef,
Profil. coupé Sur la ligne, gh, de la Redoute
Profil. coupé Sur la ligne, N O. de l'Eperon
de la Porte Dauphine

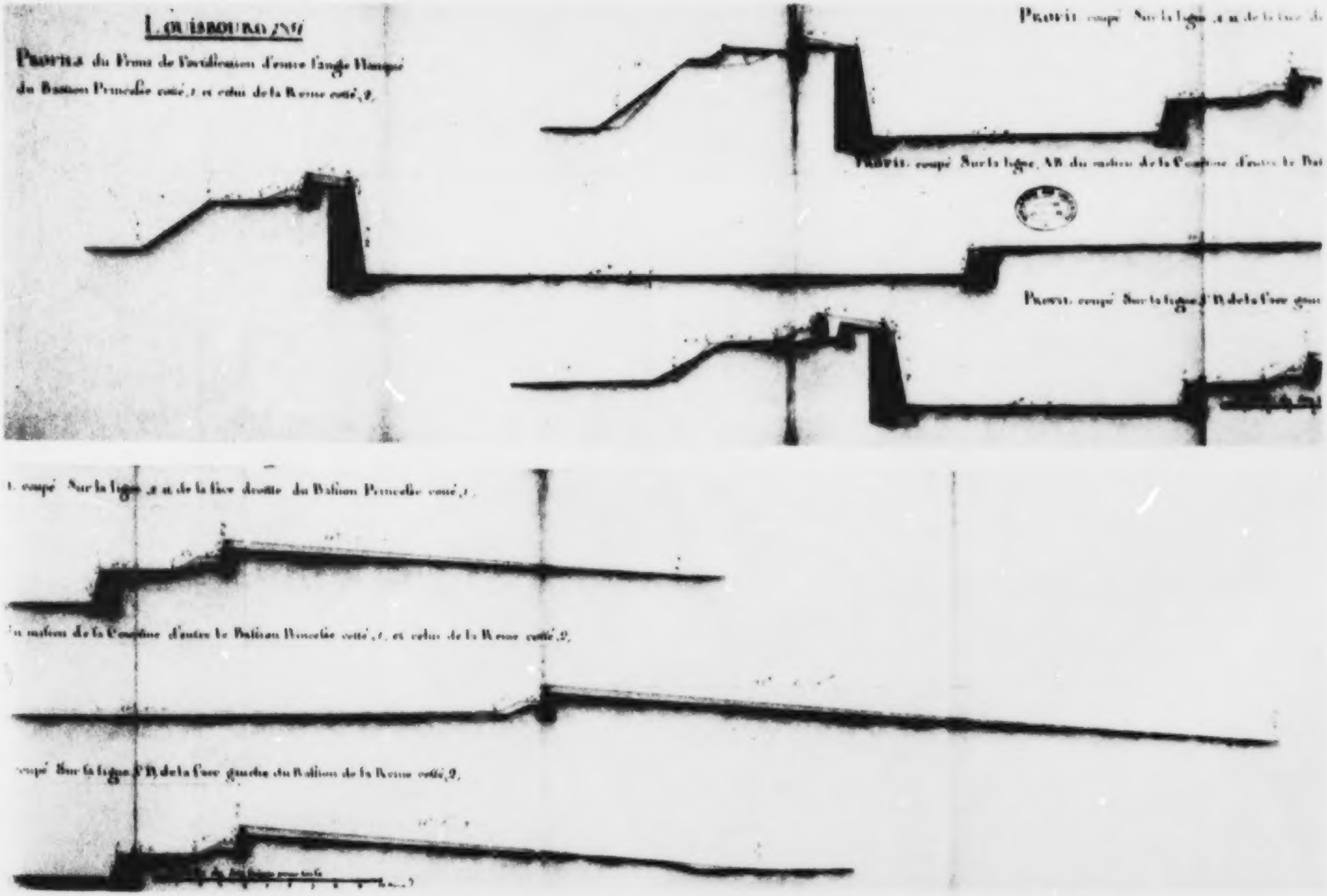
90 **Proposals to improve defences,** Franquet, 1751. The sections across the ramparts drawn to accompany the engineer's memoirs and the plans (Figs. 88, 89) on which the locations are marked. The drawings purport to show existing structures (the darker shading or lower lines) for which the improvements are proposed. The modifications consist primarily of raising and extending the glacis and raising and thickening the parapets. The Dauphin Gate area, including the redoubt, is shown. (Archives Nationales, Paris.)


Profil. coupé Sur la ligne ab, de la Courtine d'entre le Bastion du Roy
Profil. coupé Sur la ligne a d, de la face gauche d
du Roy cotté, 3, et celui de Dauphin cotté, 4.
face gauche du Bastion Dauphin cotté, 4,

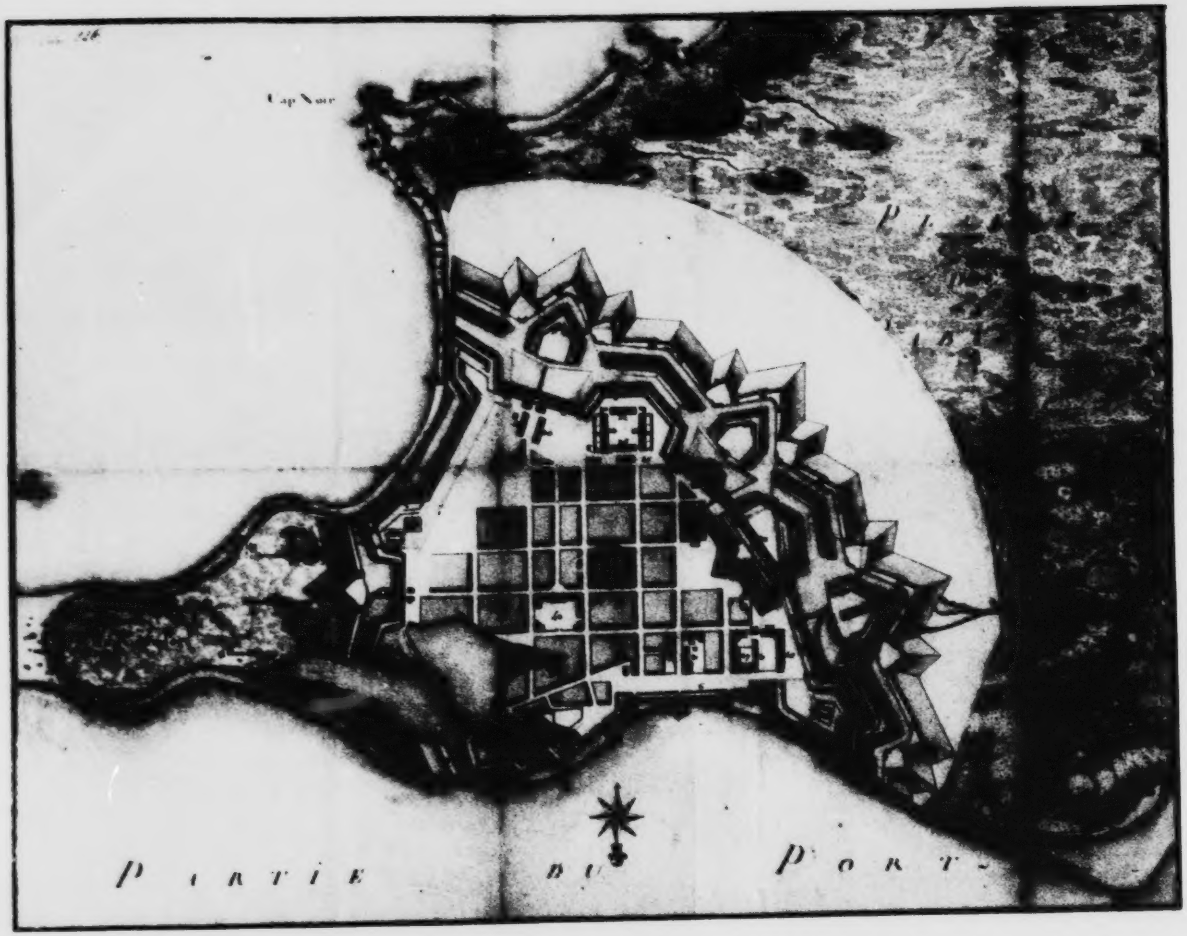
91 **Proposals to improve defences,** Franquet, 1751 (see Fig. 90). The right face of the King's Bastion, the King's-Dauphin curtain, and the left face of the Dauphin Bastion. This is one of the most difficult of Franquet's drawings to interpret because the representation of the King's Bastion rampart is contrary to other historical evidence as well as the archaeological findings. Possibly the timber framing was that of the platform installed by the British during 1745-49; if it covered the interior revetment, the true thickness of the wall might not have been available to Franquet. In the lower profile, the existing cavalier, built by the British on the Dauphin Bastion, is shown with another, larger one superimposed. (Archives Nationales, Paris.)



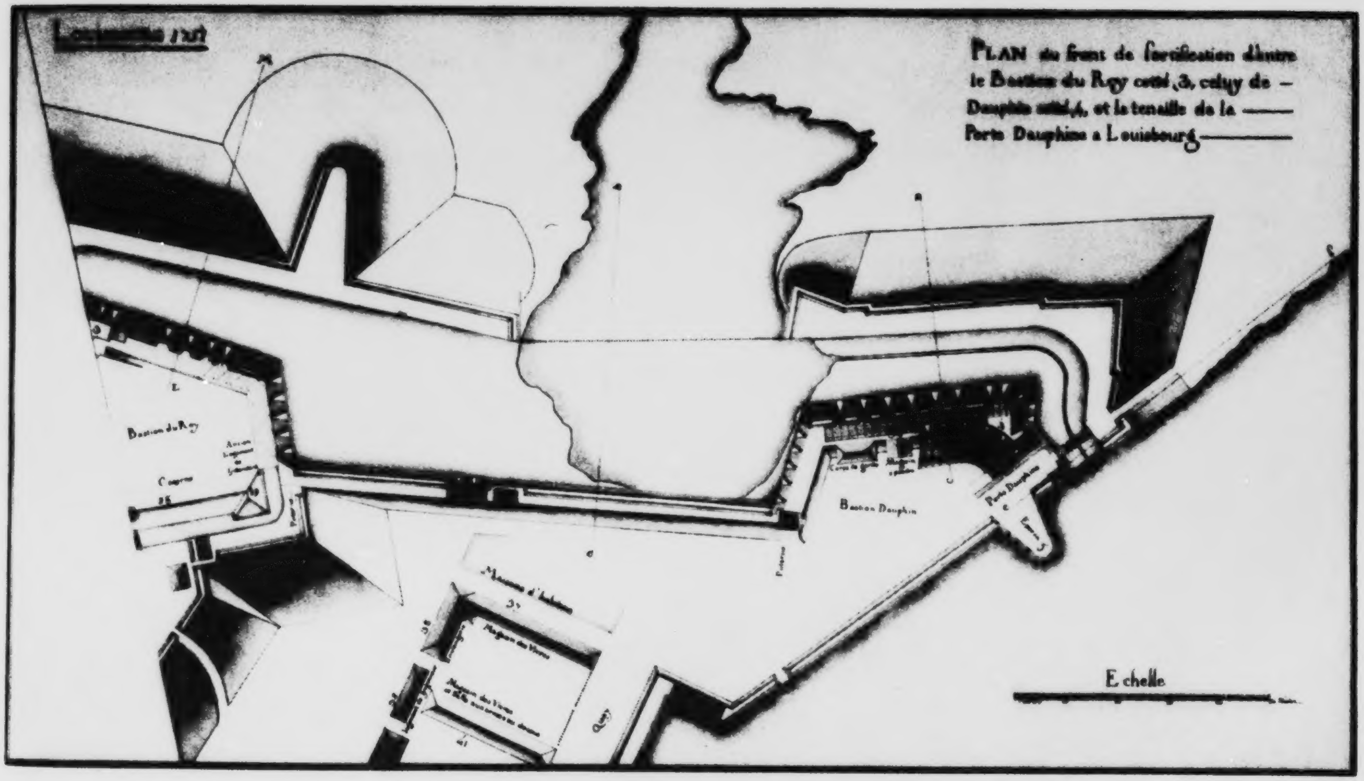
92 **Proposals to improve defences,** Franquet, 1751 (see Fig. 90). Profiles through the right face of the Queen's Bastion and the King's-Queen's curtain. (Archives du Génie, Vincennes.)


LOUISBOURG 1751
PROFILS du Front de Fortification d'entre l'angle flanqué du Bastion Princesse cotté 1 et celui de la Reine cotté 2
PROFIL coupé Sur la ligne de la face d
PROFIL coupé Sur la ligne AB du milieu de la Courtine d'entre le Bas
PROFIL coupé Sur la ligne D de la face gauc
coupé Sur la ligne de la face droitte du Bastion Princesse cotté 1
u milieu de la Courtine d'entre le Bastion Princesse cotté 1 et celui de la Reine cotté 2
coupé Sur la ligne CD de la face gauche du Bastion de la Reine cotté 2

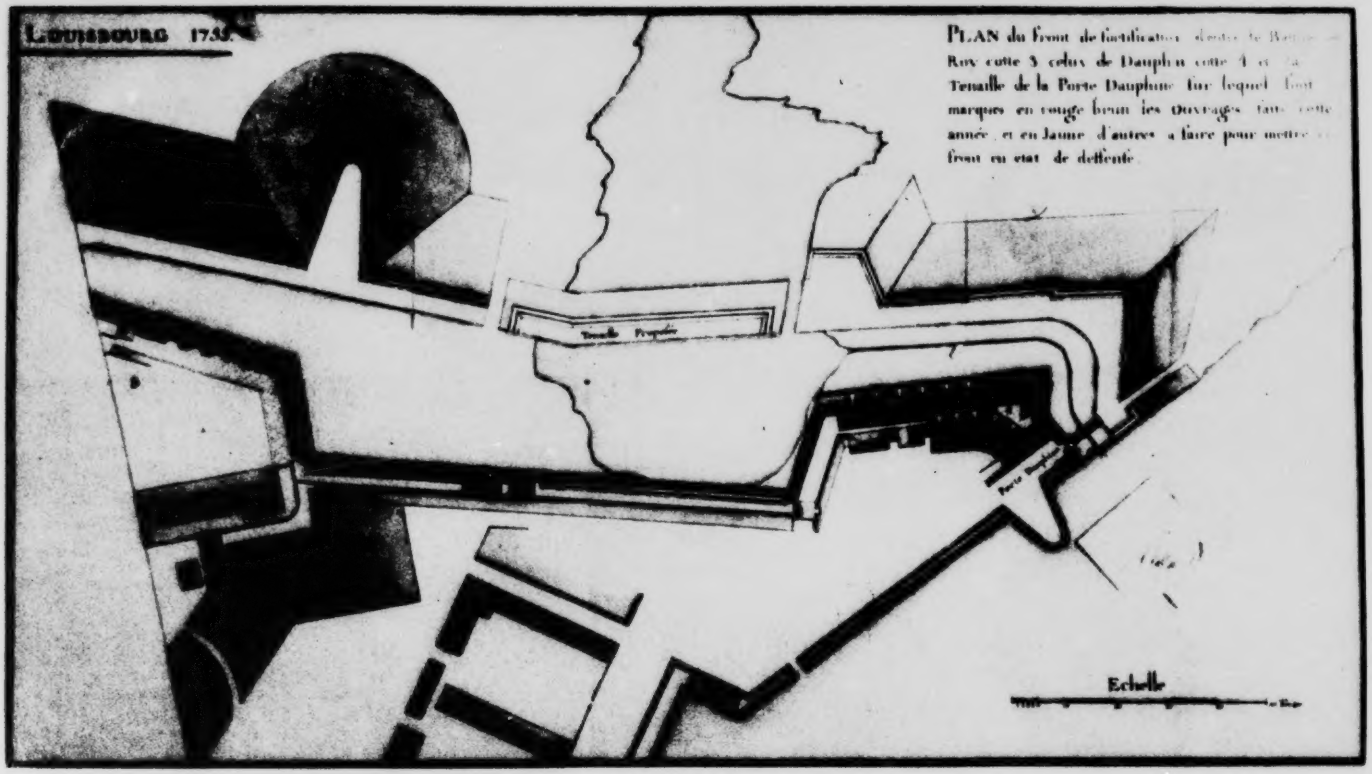
3 **Proposals to improve defences,** Franquet, 1751 (see Fig. 0). Profiles through the right face of the Princess Bastion, the Queen's-Princess curtain and the left face of the Queen's Bastion. (Archives Nationales, Paris.)



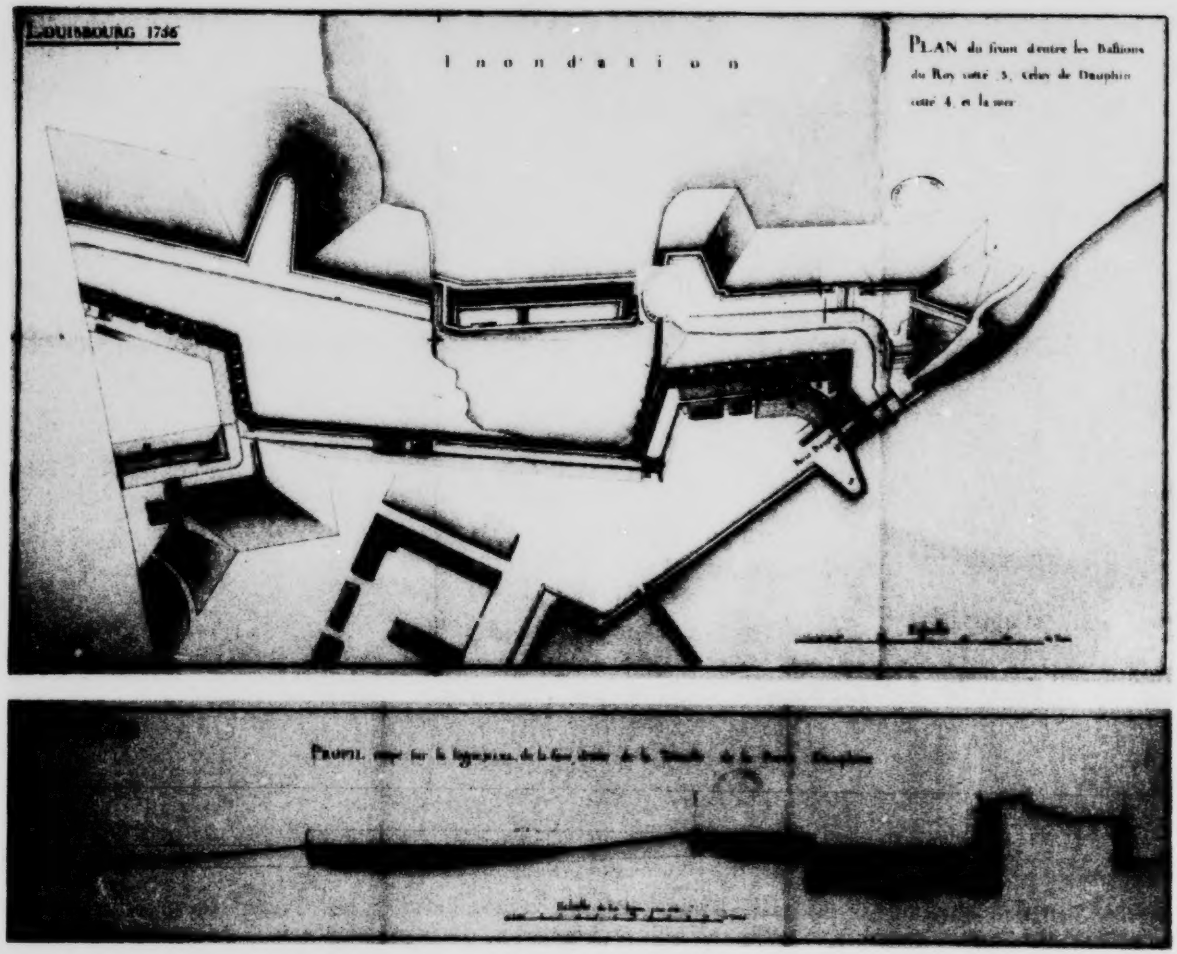
94 Proposals to improve the fortifications, Franquet, 1751. The more ambitious scheme of covering each front with a large *demi-lune* and each bastion with a counterguard. The Dauphin Bastion is redesigned as a more powerful *tenaillé* work with a cavalier conforming to the same trace on the interior, and a cavalier was proposed for the right face of the King's Bastion. (Archives Nationales, Paris.)


Louisbourg 1751
PLAN du front de fortification d'entre le Bastion du Roy cotté 3, celuy de Dauphin cotté 4, et la tenaille de la Porte Dauphine a Louisbourg
Bastion du Roy
Caserne
Bastion Dauphin
Porte Dauphine
Poterne
Magasin d'habillement
Magasin des Vivres
Quay
Echelle

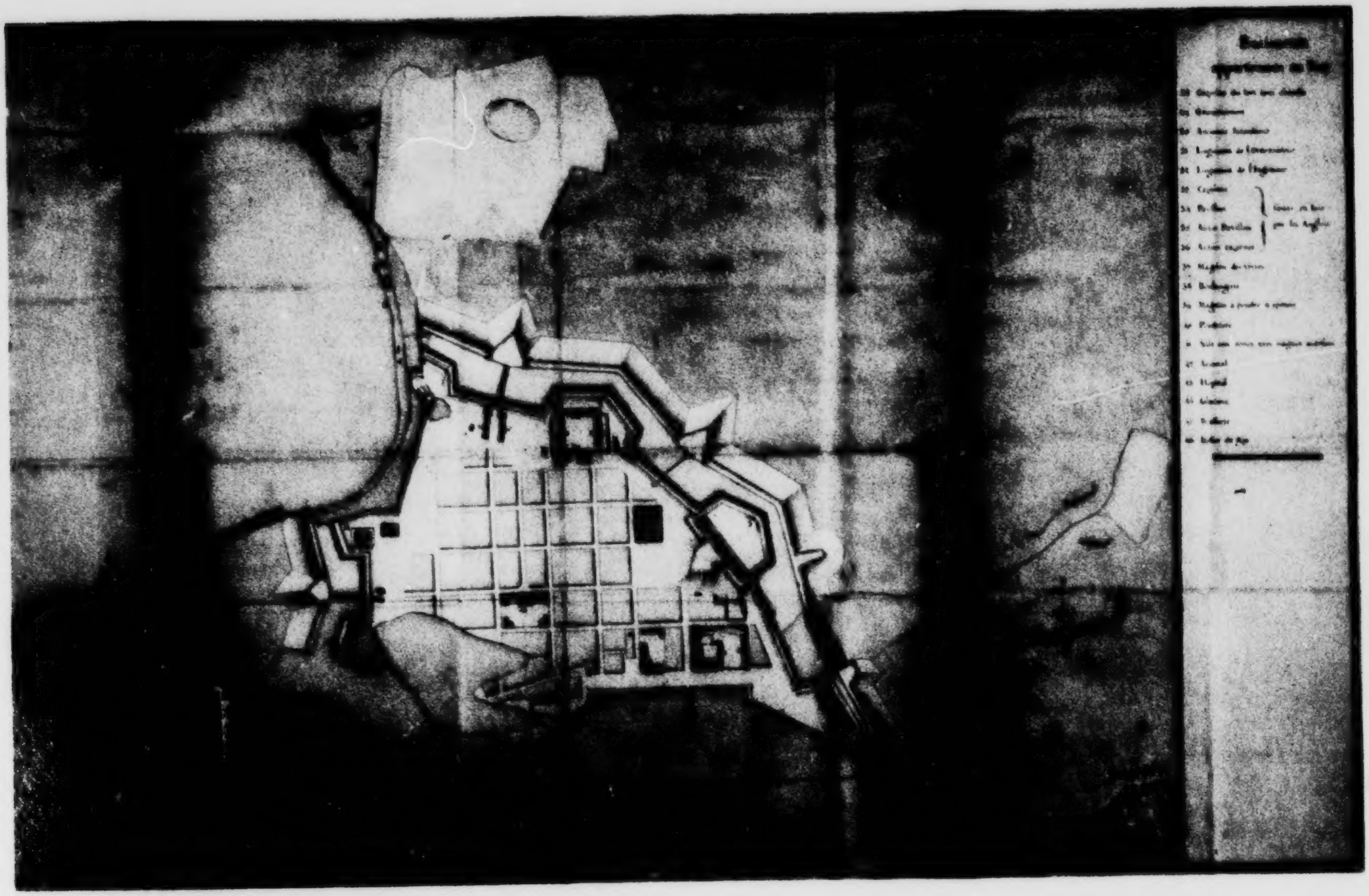
95 **The fortifications**, Franquet, 1751. Detail of the King's-Dauphin front as the engineer found it. (Archives Nationales, Paris.)


LOUISBOURG 1755
PLAN du front de fortification d'entre le Bastion du
Roy cotté 3 celuy de Dauphin cotté 4 et la
Tenaille de la Porte Dauphine ſur lequel ſont
marqués en rouge brun les Ouvrages faits cette
année, et en Jaune d'autres a faire pour mettre ce
front en etat de deffense.
Tenaille Projettée
Porte Dauphine
Echelle

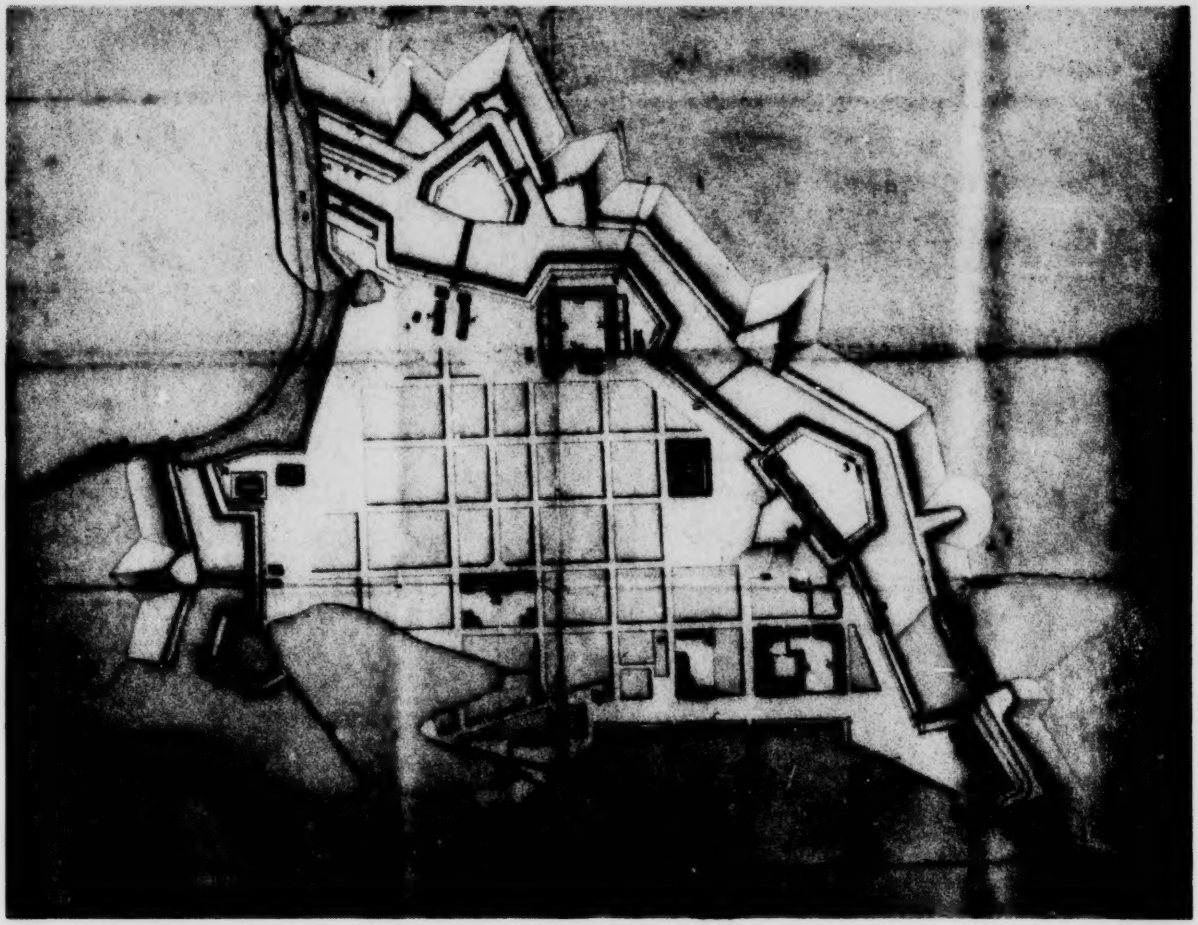
96 **King's-Dauphin front, 1755.** Preliminary design of tenaille across the pond. Proposal includes modifying *place d'armes* at right of tenaille. (Archives Nationales, Paris.)


LOUISBOURG 1756
Inondation
PLAN du front d'entre les Bastions du Roy cotté 5, celuy de Dauphin cotté 4, et la mer

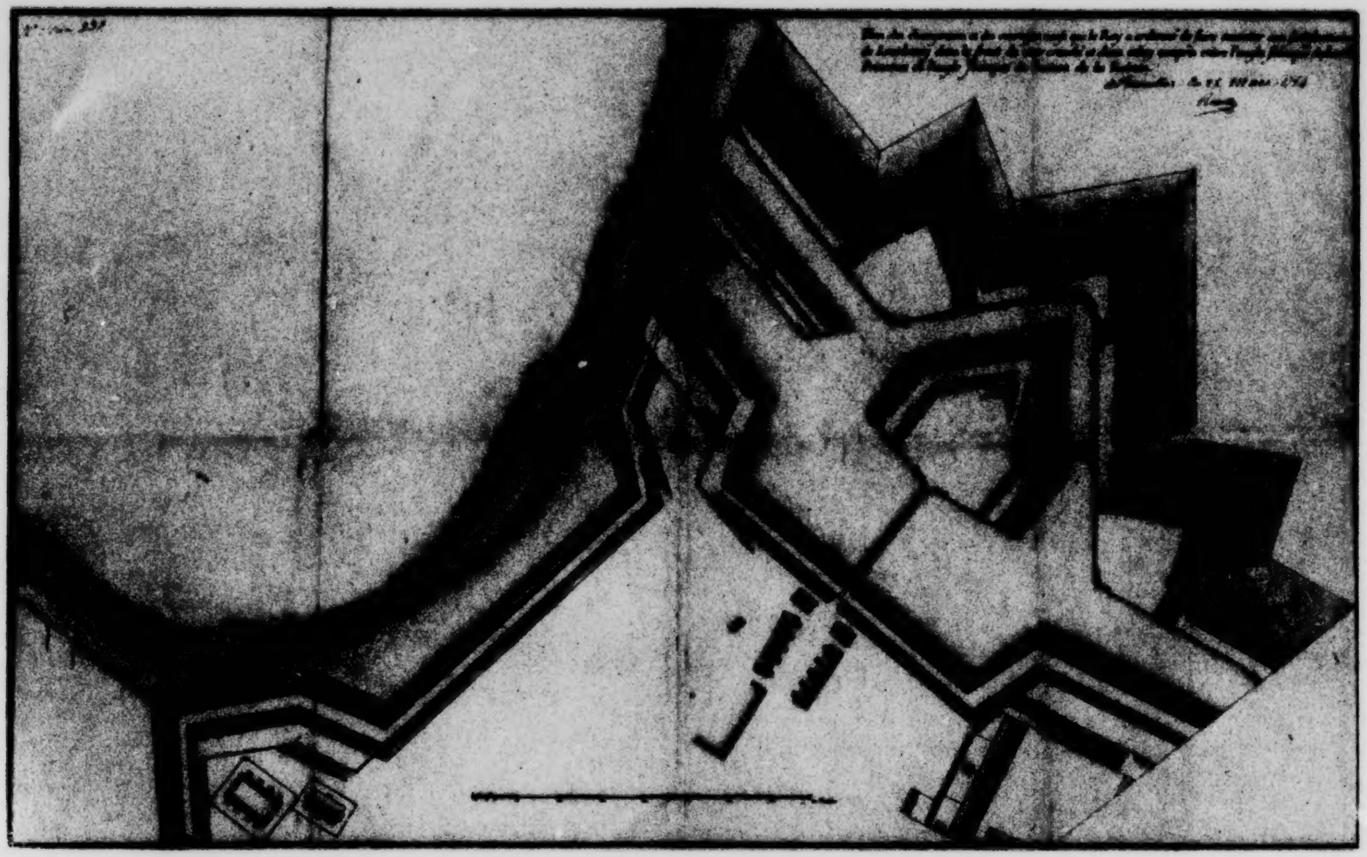
97 **King's-Dauphin front.** The revised tenaille project, 1756. The work entails modifications to the covered way and glacis in front of the gate as well, to provide more effective fields of fire across the road and entrance. The profile shows the *batardeau* in elevation. (Archives Nationales, Paris.)



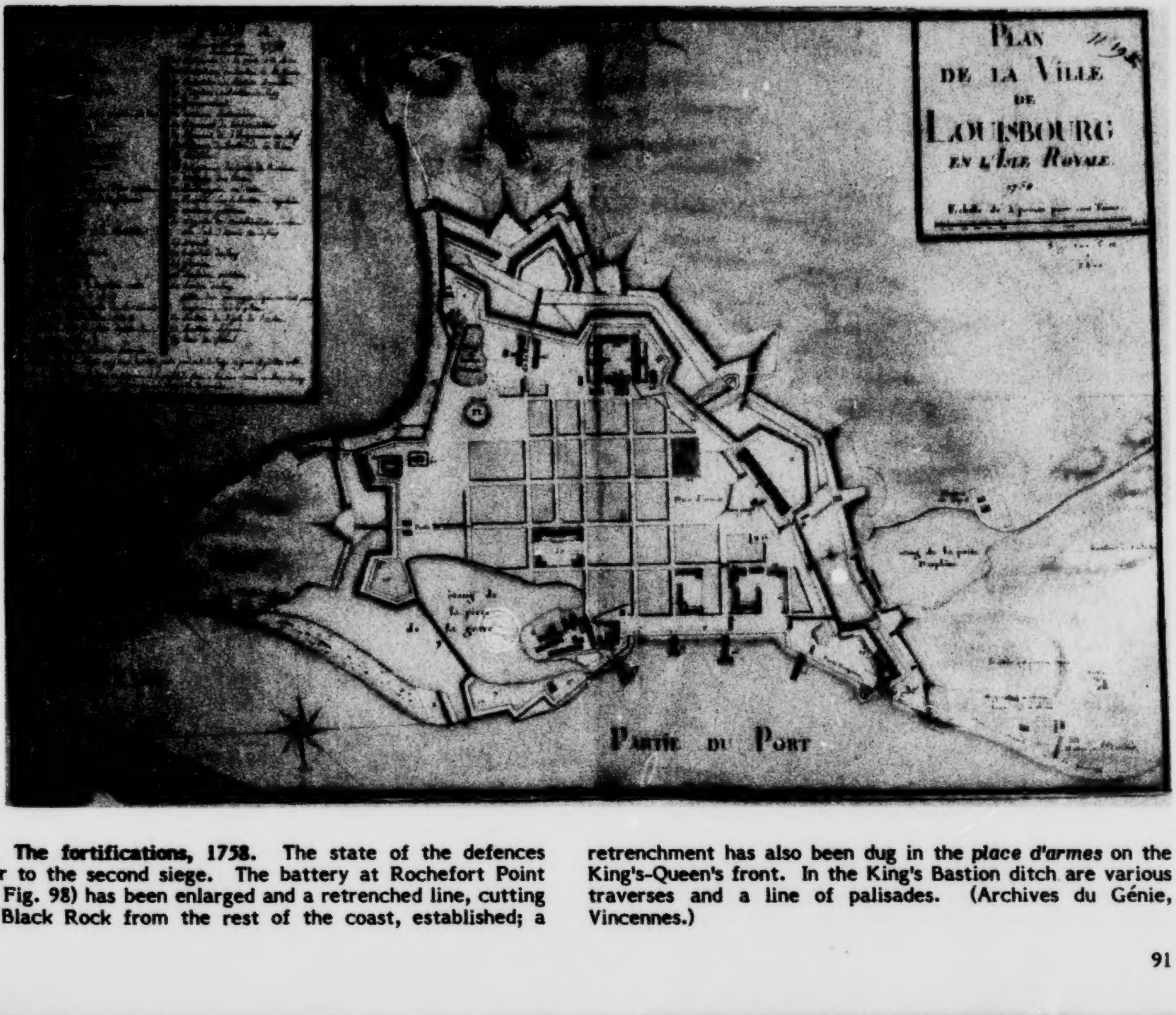
98 **The fortifications, 1756.** Note the battery at Rochefort Point, also the work in progress to lower the hills in front of the Dauphin Bastion. (Archives Nationales, Paris.)



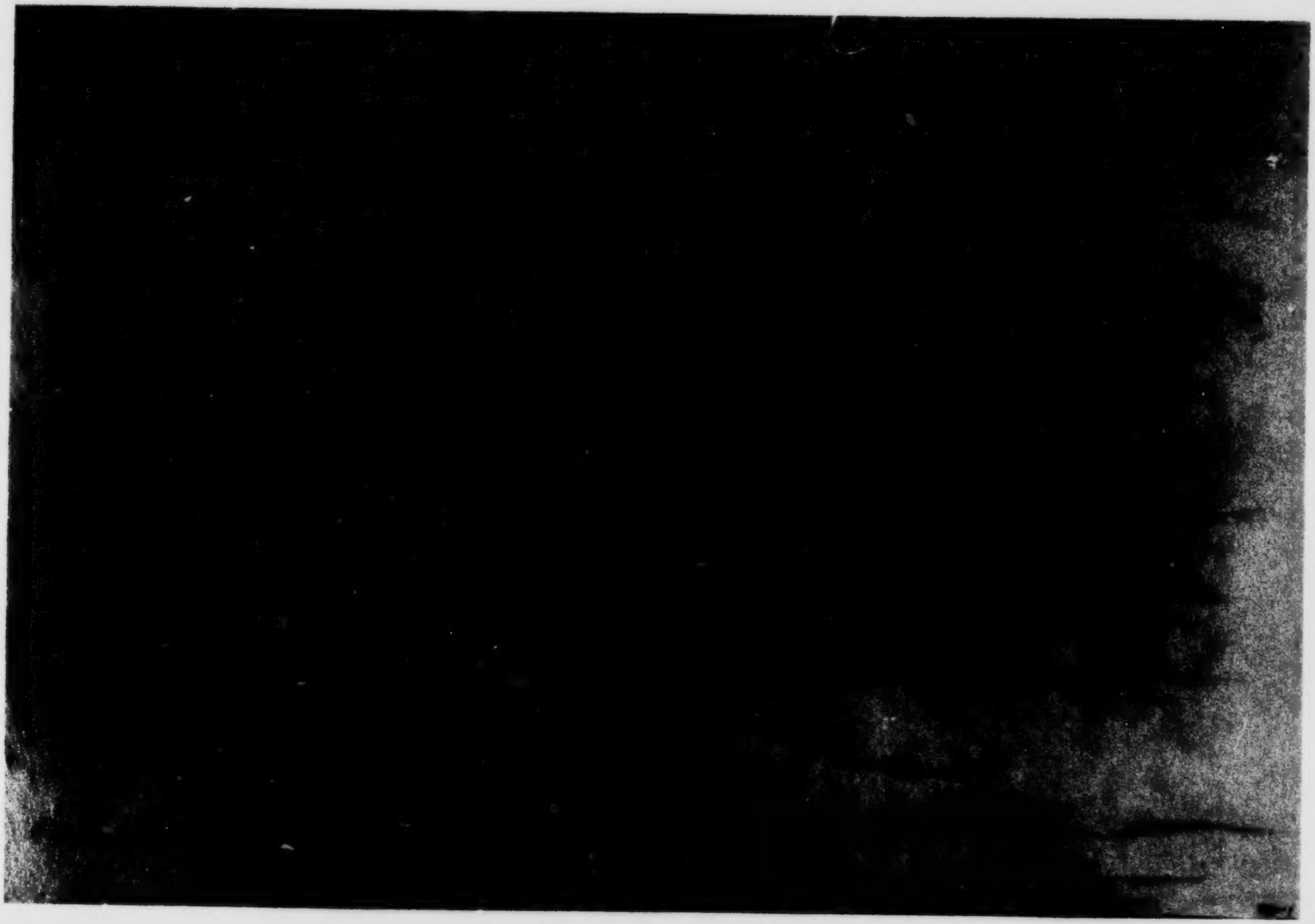
99 The fortifications, 1756. Figure 98 with foldaway flap down to indicate the *demi-lune* on the Queen's-Princess front. (Archives Nationales, Paris.)



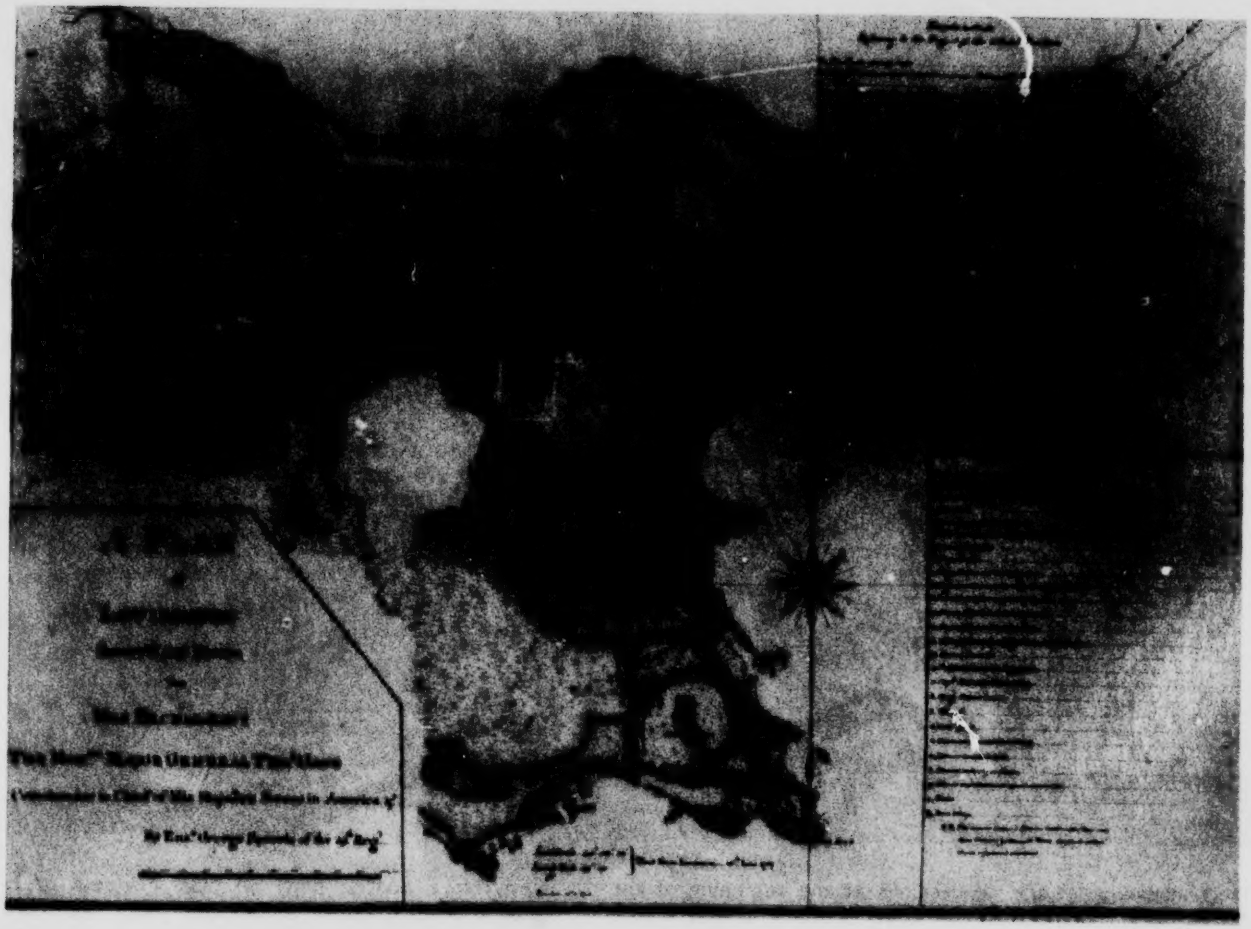
100 Queen's-Princess front. Detail showing the *demi-lune* project, as approved by the minister, 1754. (Archives Nationales, Paris.)


PLAN
DE LA VILLE
DE
LOUISBOURG
EN L'ISLE ROYALE
PARTIE DU PORT

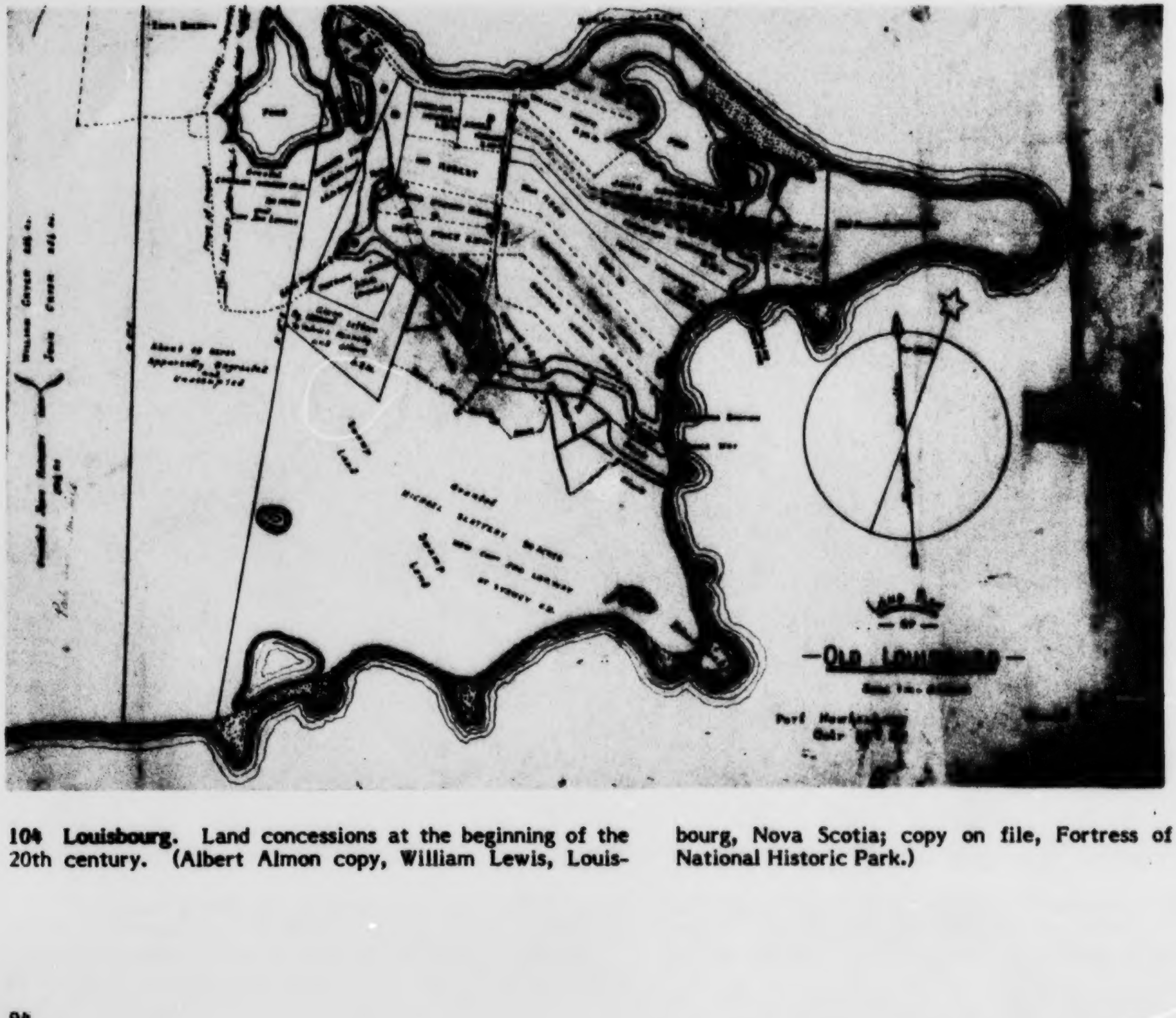
101 The fortifications, 1758. The state of the defences prior to the second siege. The battery at Rochefort Point (cf. Fig. 98) has been enlarged and a retrenched line, cutting off Black Rock from the rest of the coast, established; a retrenchment has also been dug in the *place d'armes* on the King's-Queen's front. In the King's Bastion ditch are various traverses and a line of palisades. (Archives du Génie, Vincennes.)



102 Demolition of the fortifications, François de Ruvygnes, 1760. Engineer's plan of the mine galleries dug into the ramparts. Within that plan is a general plan depicting the state of the walls after the mines had been exploded. Profiles at right show the rubble collapse beneath outlines of what had previously existed. (Royal United Services Institution, London.)



103 The town after demolition of the ramparts, George Sproule, 1767. The quay and Pièce de la Grave are already eroding or being covered by beach gravel. Note the blockhouse on the glacis in front of the King's Bastion and the causeway leading to it. (William L. Clements Library, University of Michigan, Ann Arbor, Thomas Gage Papers.)



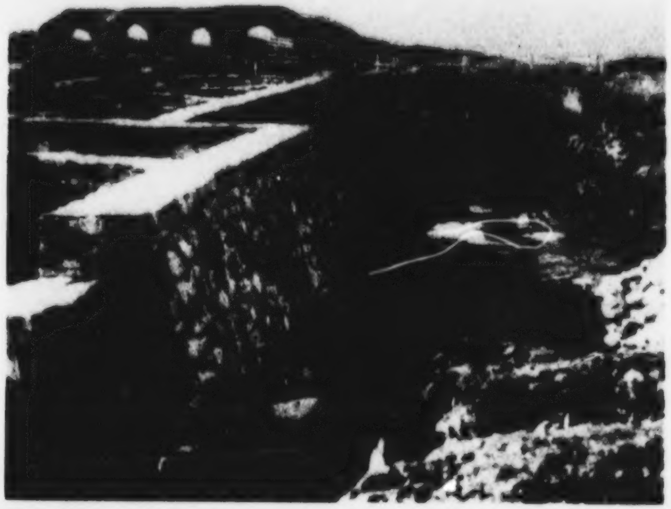
104 Louisbourg. Land concessions at the beginning of the 20th century. (Albert Almon copy, William Lewis, Louisbourg, Nova Scotia; copy on file, Fortress of Louisbourg National Historic Park.)

105 Stabilization of right flank casemates. Probably Kennelly's work in the 1900s. Looking across the terreplein of the King's Bastion; ruins of barracks at right. (Fortress of Louisbourg NHP.)

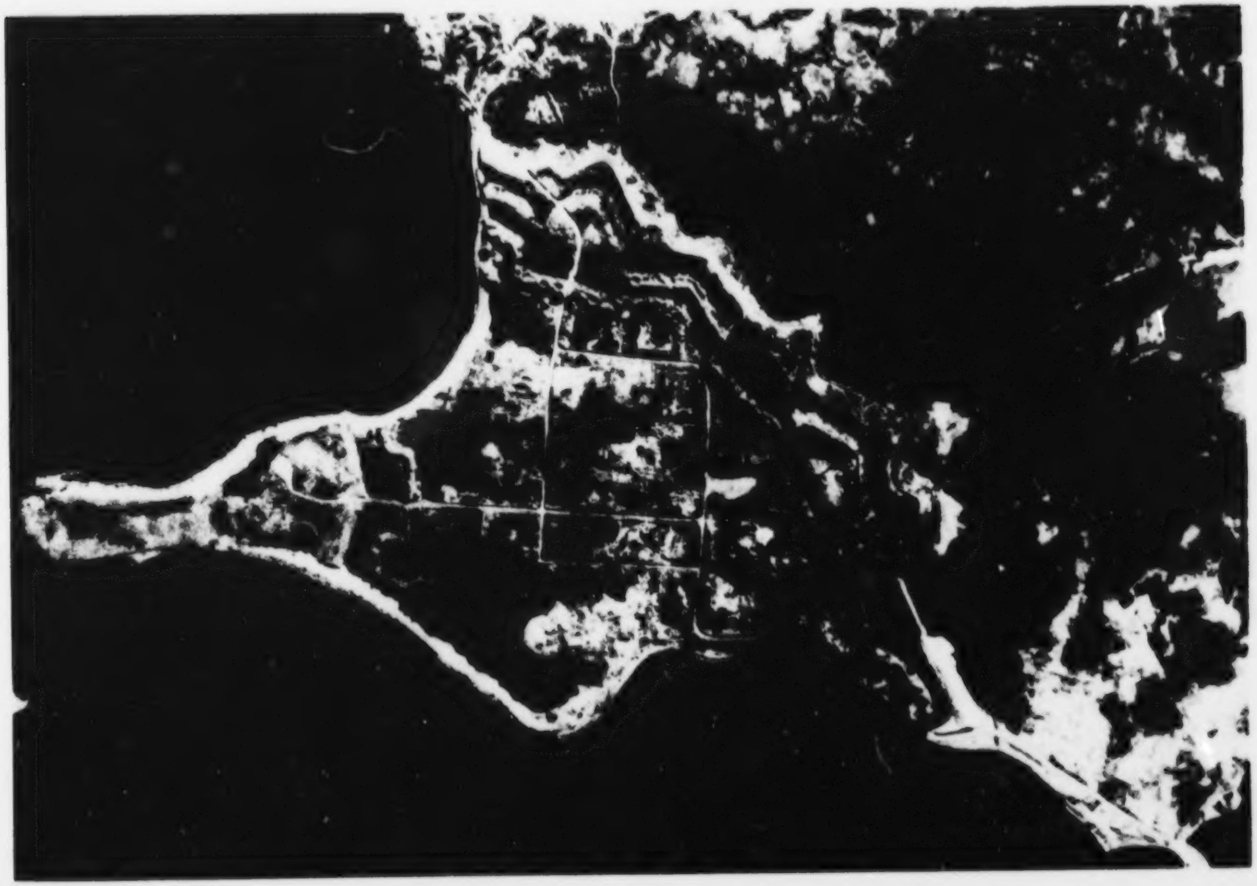
106 Restored left flank casemates, complete with interior revetment (1930s). (Fortress of Louisbourg NHP.)

107 Stabilization of the barracks' foundations, 1930s. Rubble is stockpiled in the townside *place d'armes* (upper centre). (Fortress of Louisbourg NHP.)

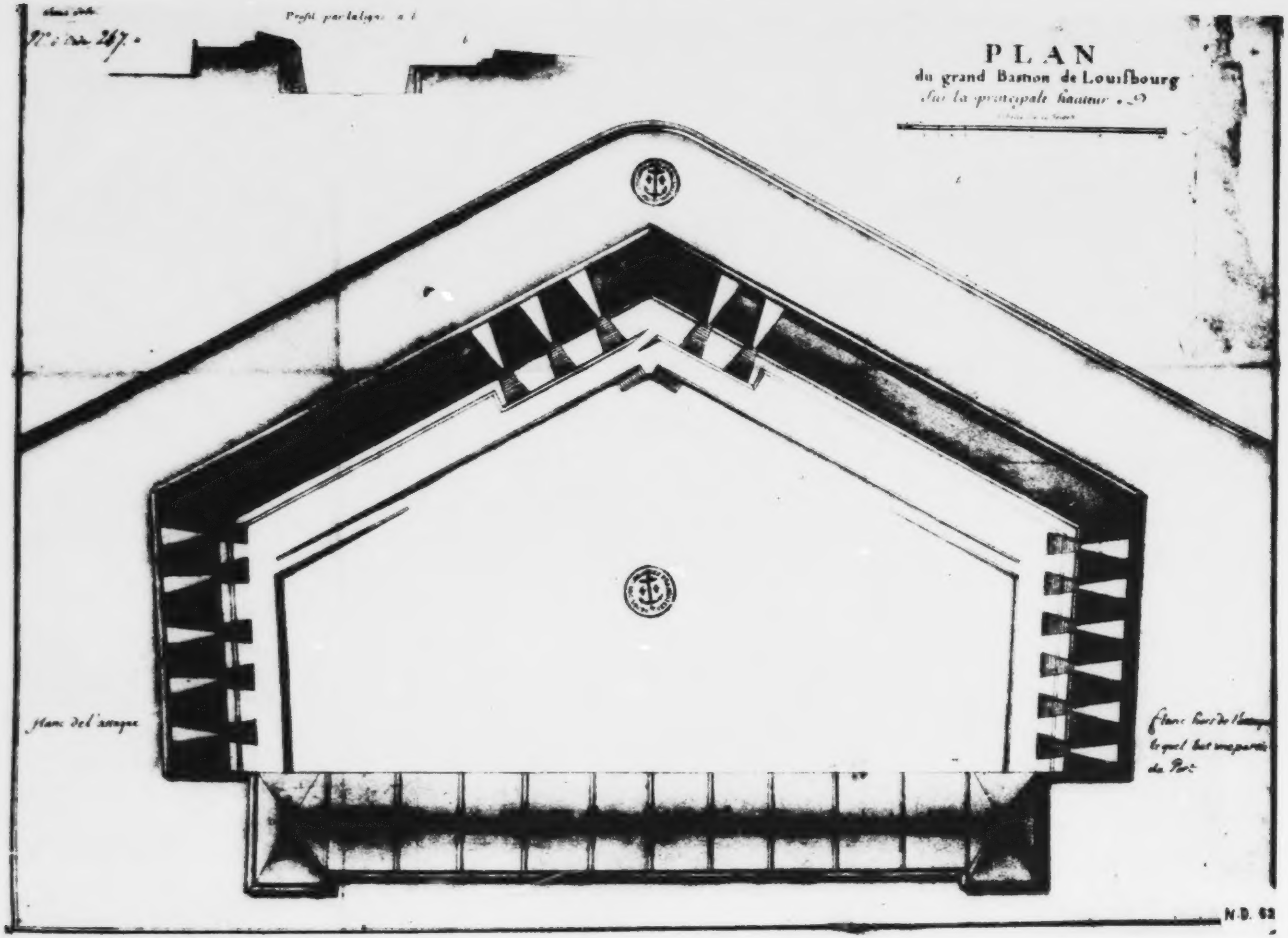
108 Stabilized ruins of the barracks, 1940s. The guardhouse in the *place d'armes* (centre left) has also been excavated and stabilized. Background, the park's museum building. (Fortress of Louisbourg NHP.)



109 The stabilized barracks as seen from the ditch. The sloping basement walls of the governor's wing are in foreground; in background, stabilized right flank casemates. (Fortress of Louisbourg NHP.)

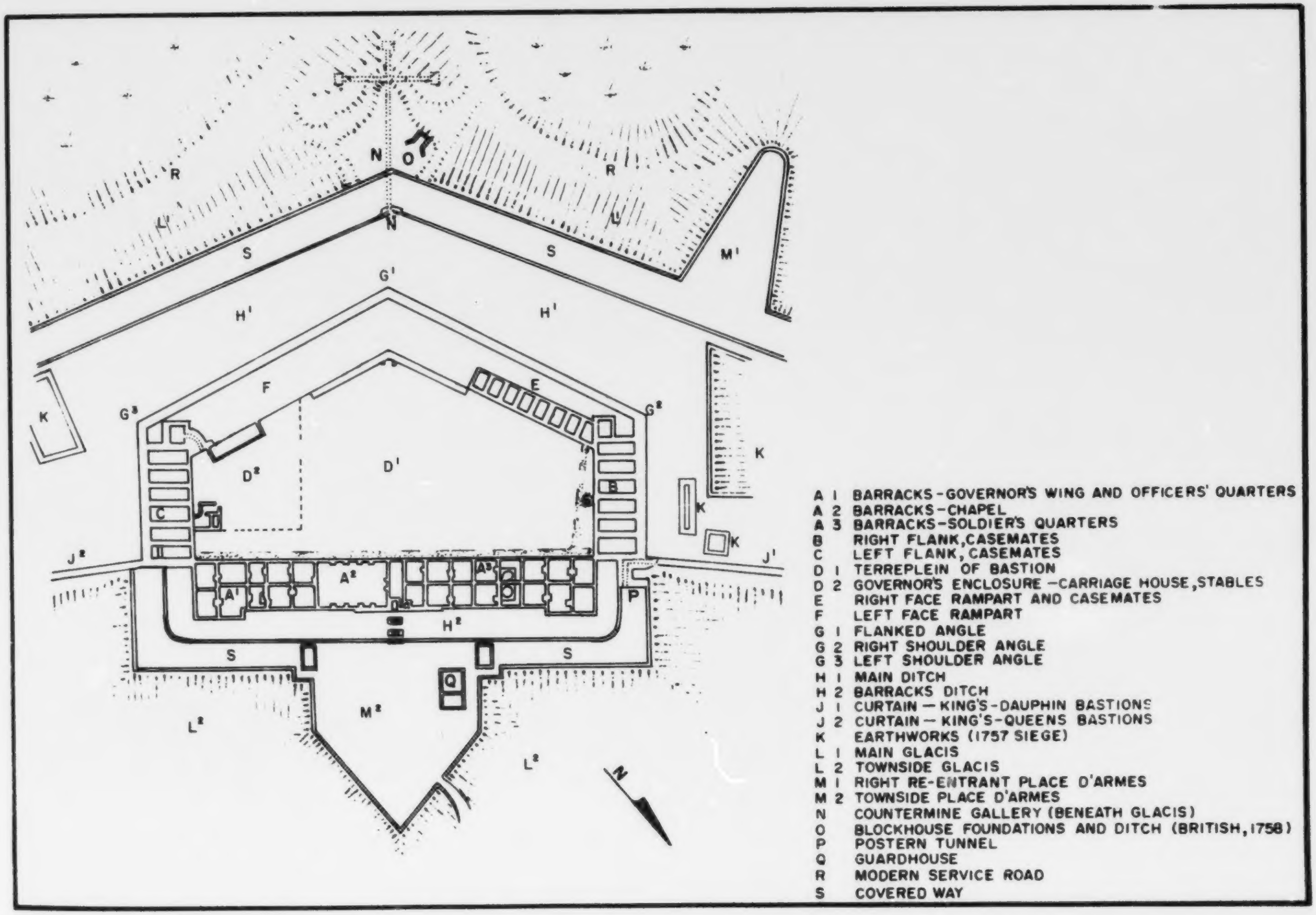


110 Aerial view of town and fortifications prior to restoration programme, 1960. Demolition craters in ramparts are clearly visible, as is the post-demolition British blockhouse on the capital line of the King's Bastion; the road leading to it from the museum cuts across the governor's wing of the barracks and the left face of the bastion. Note the stabilized remains of the barracks, the hospital and the *commissaire-ordonnateur's* house; also the various access roads around and through the ramparts. (Fortress of Louisbourg NHP.)

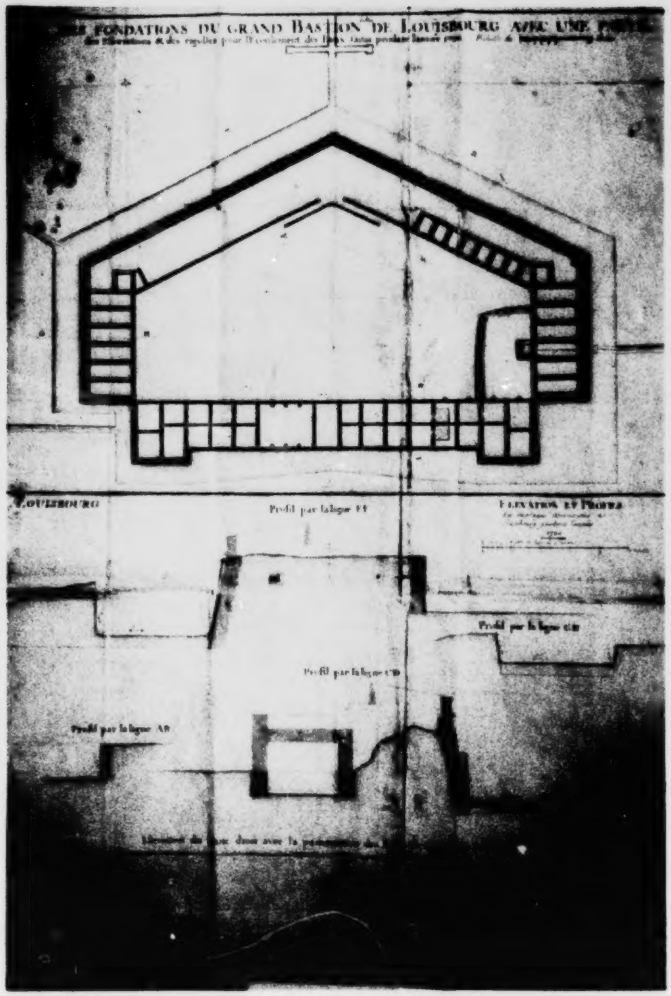


PLAN
du grand Bastion de Louisbourg
sur la principale hauteur
Profil par la ligne a b
b
flanc de l'attaque
N.D. 62

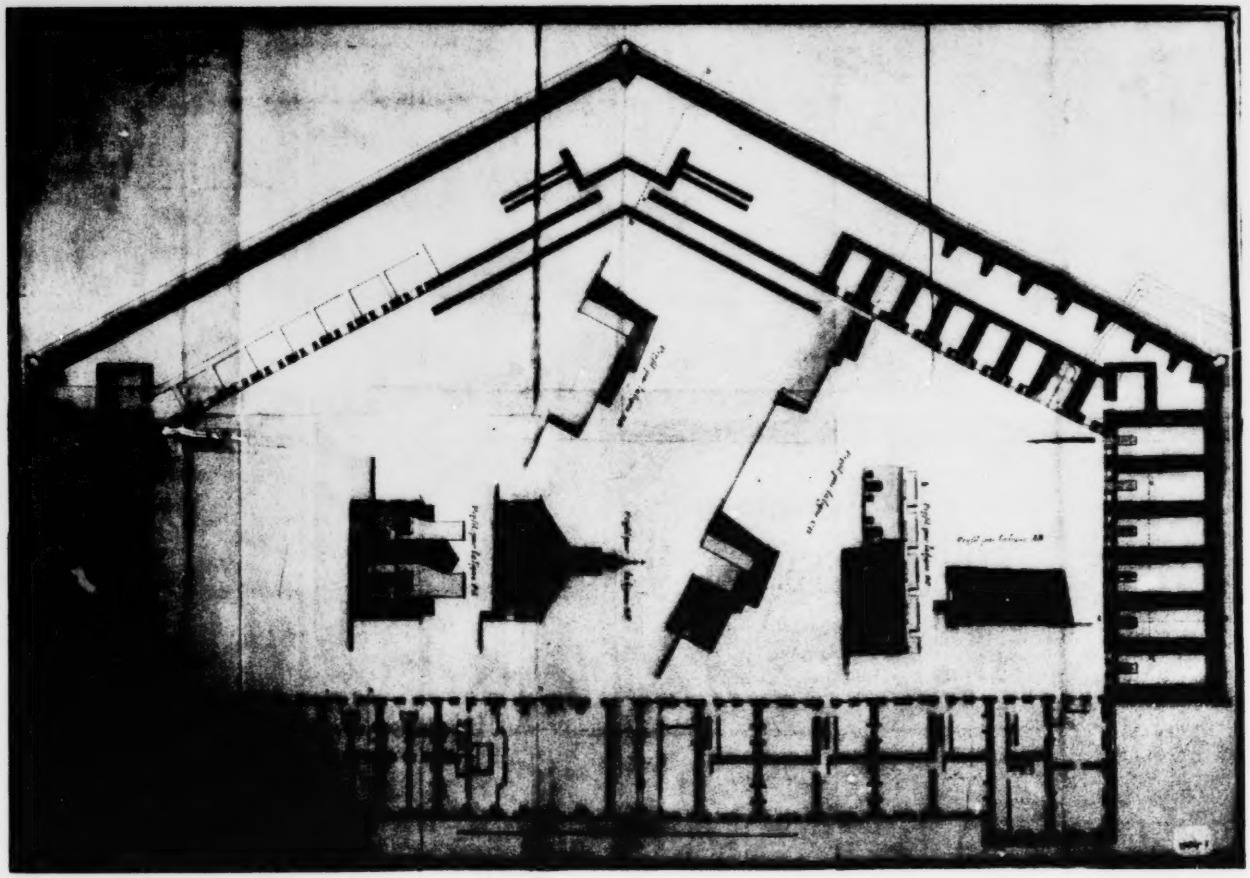
111 **The King's Bastion,** early proposals. Undated plan accompanies Verville's 1717 *devis.* Of particular interest is the design of the parapet: a sloping revetment and a superior slope aligned on the covered way. Embrasures were to be set in the parapets of the faces as well as the flanks. (Archives Nationales, Paris.)


N
O
R
R
L¹
L¹
S
S
N
G¹
H¹
H¹
M¹
F
E
G³
G²
K
K
K
K
D²
D¹
C
B
J²
J¹
A²
A³
A¹
P
H²
S
S
Q
M²
L²
L²
N
A 1 BARRACKS-GOVERNOR'S WING AND OFFICERS' QUARTERS
A 2 BARRACKS-CHAPEL
A 3 BARRACKS-SOLDIER'S QUARTERS
B RIGHT FLANK, CASEMATES
C LEFT FLANK, CASEMATES
D 1 TERREPLEIN OF BASTION
D 2 GOVERNOR'S ENCLOSURE - CARRIAGE HOUSE, STABLES
E RIGHT FACE RAMPART AND CASEMATES
F LEFT FACE RAMPART
G 1 FLANKED ANGLE
G 2 RIGHT SHOULDER ANGLE
G 3 LEFT SHOULDER ANGLE
H 1 MAIN DITCH
H 2 BARRACKS DITCH
J 1 CURTAIN — KING'S-DAUPHIN BASTIONS
J 2 CURTAIN — KING'S-QUEENS BASTIONS
K EARTHWORKS (1757 SIEGE)
L 1 MAIN GLACIS
L 2 TOWNSIDE GLACIS
M 1 RIGHT RE-ENTRANT PLACE D'ARMES
M 2 TOWNSIDE PLACE D'ARMES
N COUNTERMINE GALLERY (BENEATH GLACIS)
O BLOCKHOUSE FOUNDATIONS AND DITCH (BRITISH, 1758)
P POSTERN TUNNEL
Q GUARDHOUSE
R MODERN SERVICE ROAD
S COVERED WAY

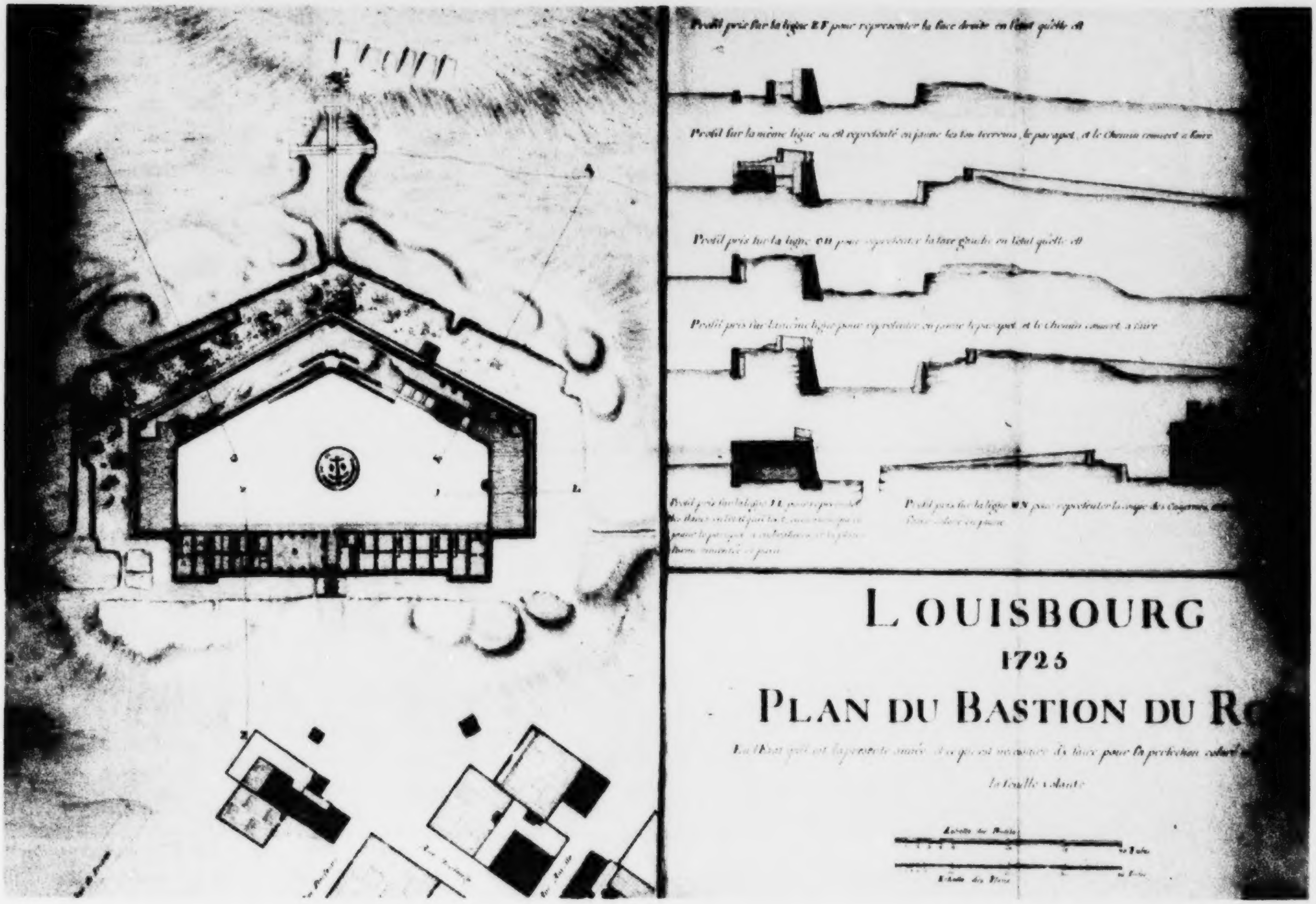
112 **King's Bastion:** key to principal features. (Drawing by T.M. Smith.)


FONDATIONS DU GRAND BASTION DE LOUISBOURG AVEC UNE
LOUISBOURG
Profil par la ligne EF
ELEVATION ET PROFILS
Profil par la ligne GH
Profil par la ligne CD
Profil par la ligne AB

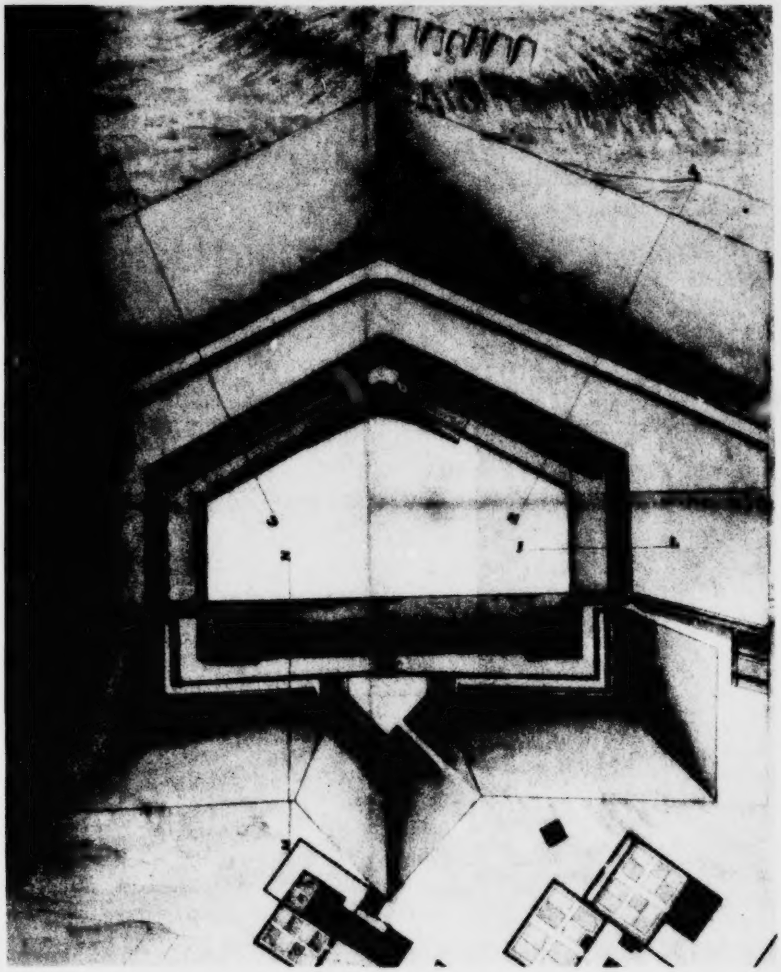
113 King's Bastion, construction progress, 1720. The bastion is depicted as actually laid out. Work accomplished may be compared to the general plans of the town (Figs. 71, 72). Work has not started on the escarps, shown here as descending in a series of steps at the rear; this method was not followed. The parapet has been modified from that previously proposed (Fig. 111). (Archives du Génie, Vincennes.)



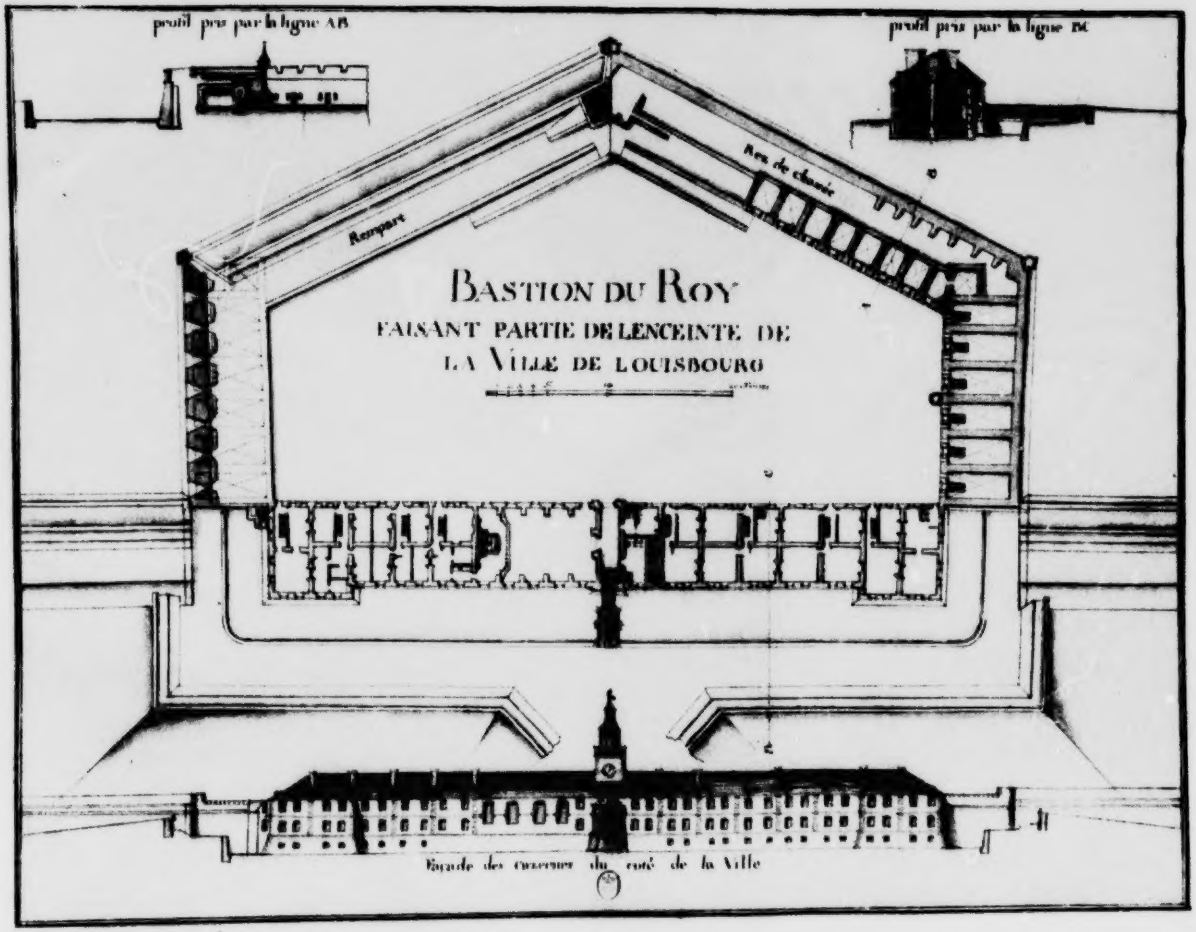
114 **King's Bastion,** construction progress, 1724. The bastion is a free-standing unit: note quoins at extremities of flank escarps. Profile CD clearly shows glacis and superior slope of parapet on same alignment. The interior revetments of the faces overlap those of the flanks, thus blocking off a casemate vent on each flank. No floors are indicated in the casemates at terreplein level; the steps leading down into the casemates are shown as having been built, but none were found in excavation. Note also the latrine depicted in right face casemate (8R). (Archives du Génie, Vincennes.)


LOUISBOURG
1725
PLAN DU BASTION DU R

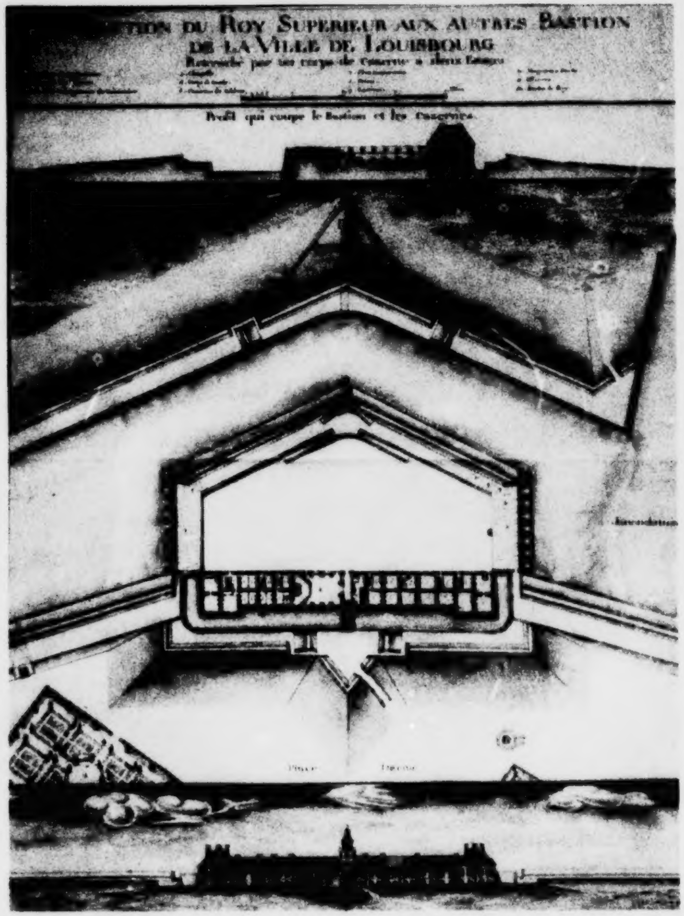
115 King's Bastion, construction progress and projections, Verrier, 1725. Note the gap on the right face for bringing construction material into the bastion. The relationship between glacis and parapet is clearly shown. (Archives Nationales, Paris.)



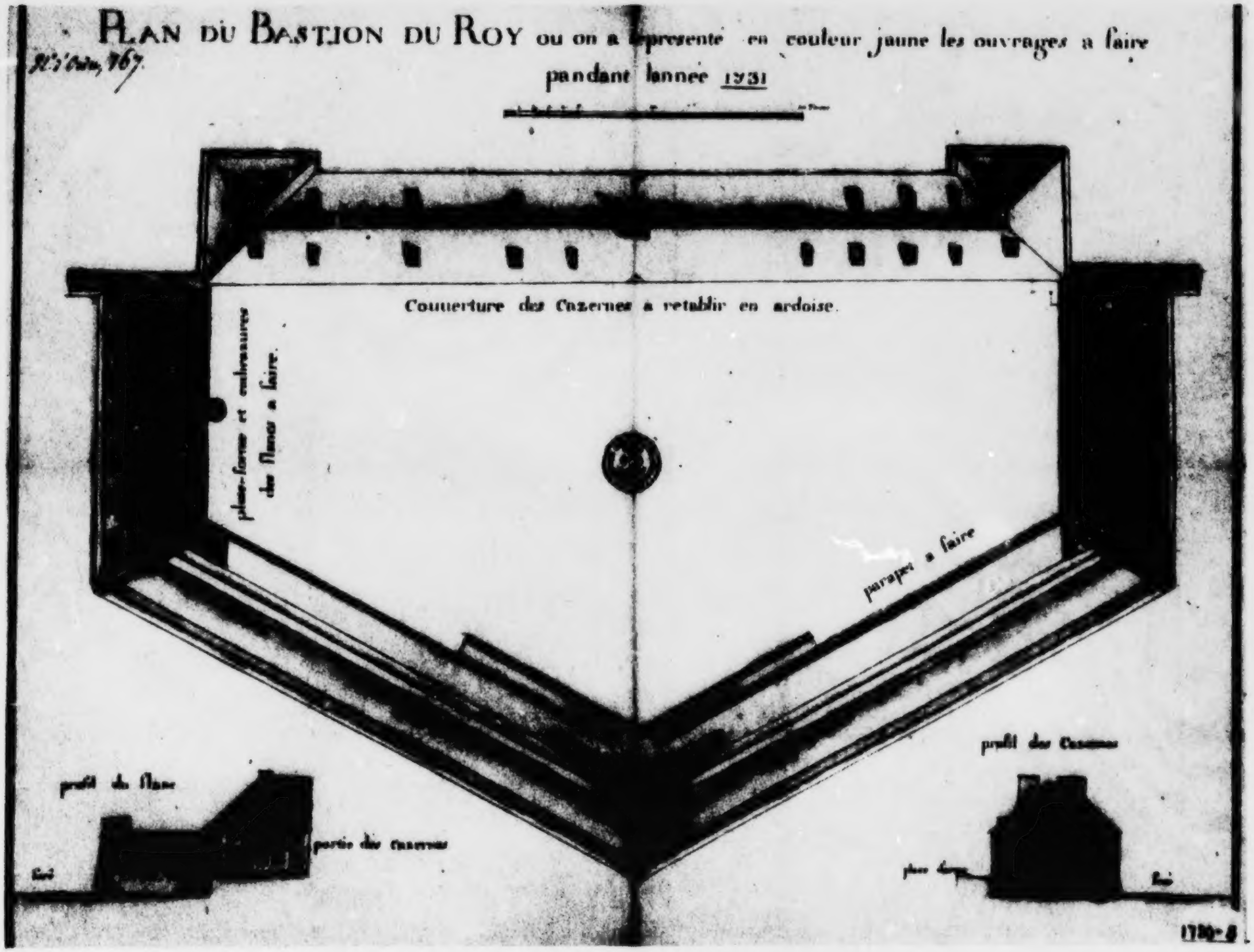
16 **King's Bastion.** Representation as it should look when completed (a foldaway flap over Fig. 115). Seven embrasures are allowed for on each flank; also *guérites* at each shoulder angle. (Archives Nationales, Paris.)


profil pris par la ligne AB
profil pris par la ligne BC
Rempart
Rez de chaussée
BASTION DU ROY
FAISANT PARTIE DE LENCEINTE DE
LA VILLE DE LOUISBOURG
Facade des Casernes du costé de la Ville

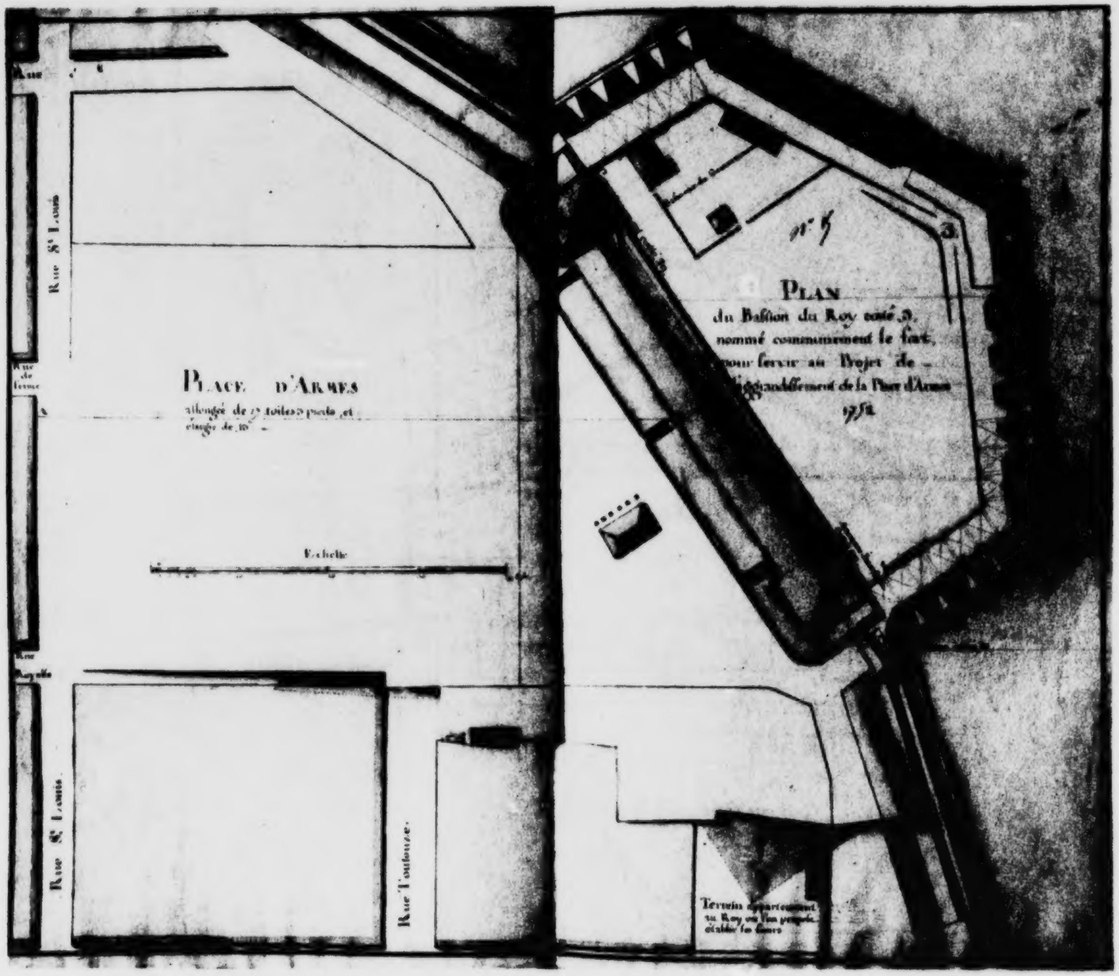
117 **King's Bastion.** Undated, unsigned plan. Representation of the barracks and clock-tower suggests a date in the late 1720s, before alterations were decided upon. Of chief interest is the Y-shaped vent in the interior revetment, leading to right shoulder casemate (7R). (Bibliothèque Nationale, Paris.)


DU ROY SUPERIEUR AUX AUTRES BASTION
DE LA VILLE DE LOUISBOURG
Profil qui coupe le Bastion et les Casernes

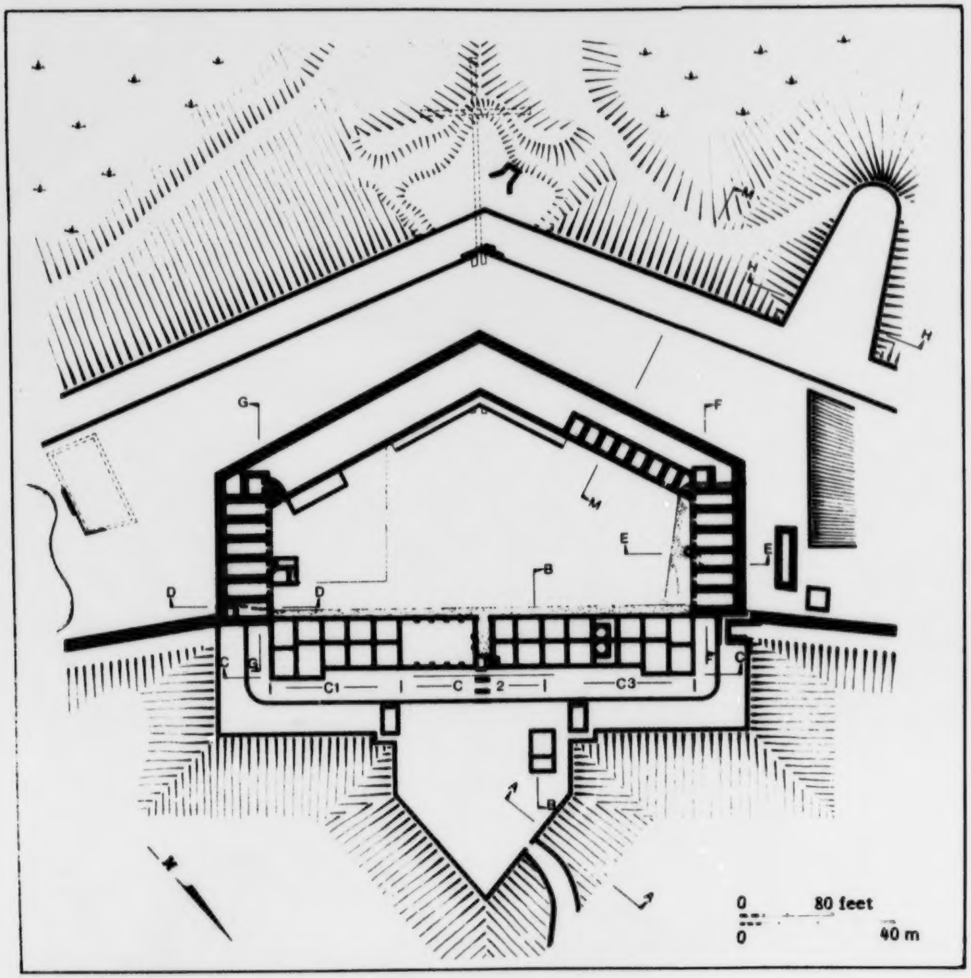
118 King's Bastion. Undated, unsigned plan. Representation of barracks suggests a late 1720s or early 1730s date. The plan is chiefly of interest for its identification of various casemates as prisons and latrines. Note also the mine gallery under the glacis. In the profile above, the parapet of the face and the glacis are on the same alignment; the interior revetments of the flank and the face parapets are shown at the same elevation. (Archives du Génie, Vincennes.)


PLAN DU BASTION DU ROY ou on a représenté en couleur jaune les ouvrages a faire pandant lannée 1731
Couuerture des Cazernes a retablir en ardoise.
plate-forme et embrasures des flancs a faire.
parapet a faire
profil du flanc
partie des Cazernes
profil des Cazernes
place darme
1730-8

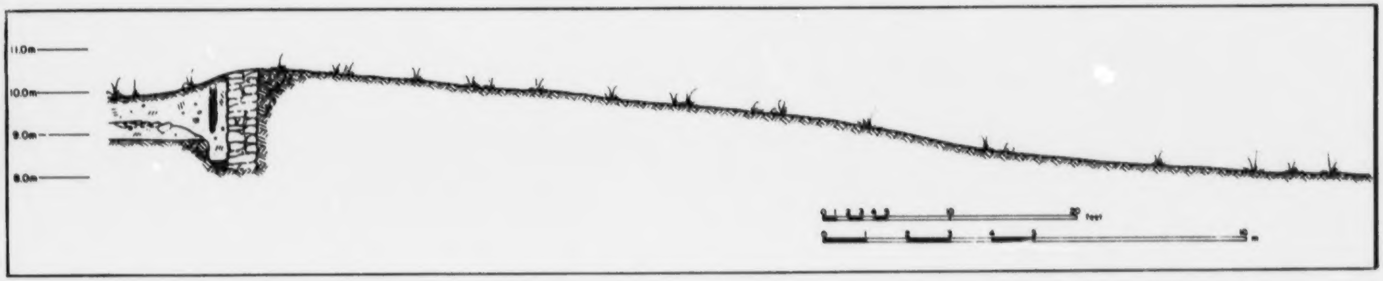
119 King's Bastion, construction proposals for 1731. The plan is of particular interest for the way the flanks are represented with ashlar paving. The embrasures have been reduced from seven to six on each flank. (Archives Nationales, Paris.)


Rue St Louis
Rue
Rue Royalle
Rue St Louis
Rue Toulouze
Place d'Armes
allongée de 17 toises 3 pieds et élargie de 10
Echelle
N° 5
3
Plan
du Bastion du Roy coté 3,
nommé communément le fort,
pour servir au Projet de
l'aggrandissement de la Place d'Armes
1752
Terrain appartenant au Roy

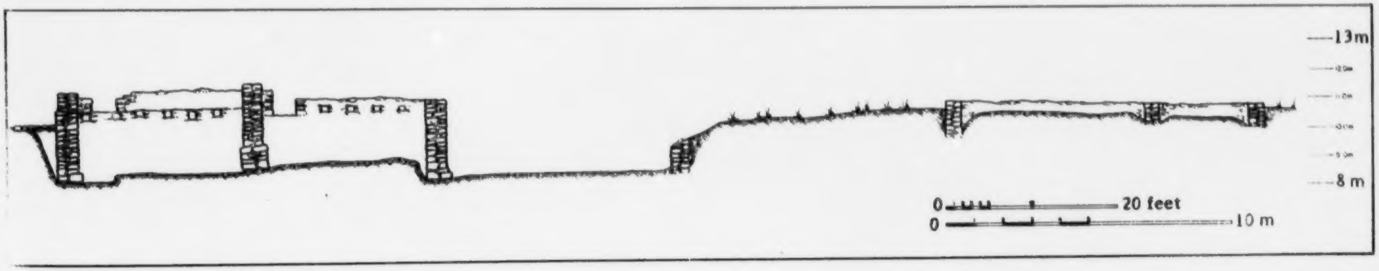
120 **King's Bastion** as it appeared in 1752. The parapets of the flanks have been increased to the width of the ones on the faces; embrasures are set in the right face parapet. (Archives du Génie, Vincennes.)


G
F
M
E
E
B
D
D
C
G
C1
C
2
C3
F
C
B
N
0
80 feet
0
40 m

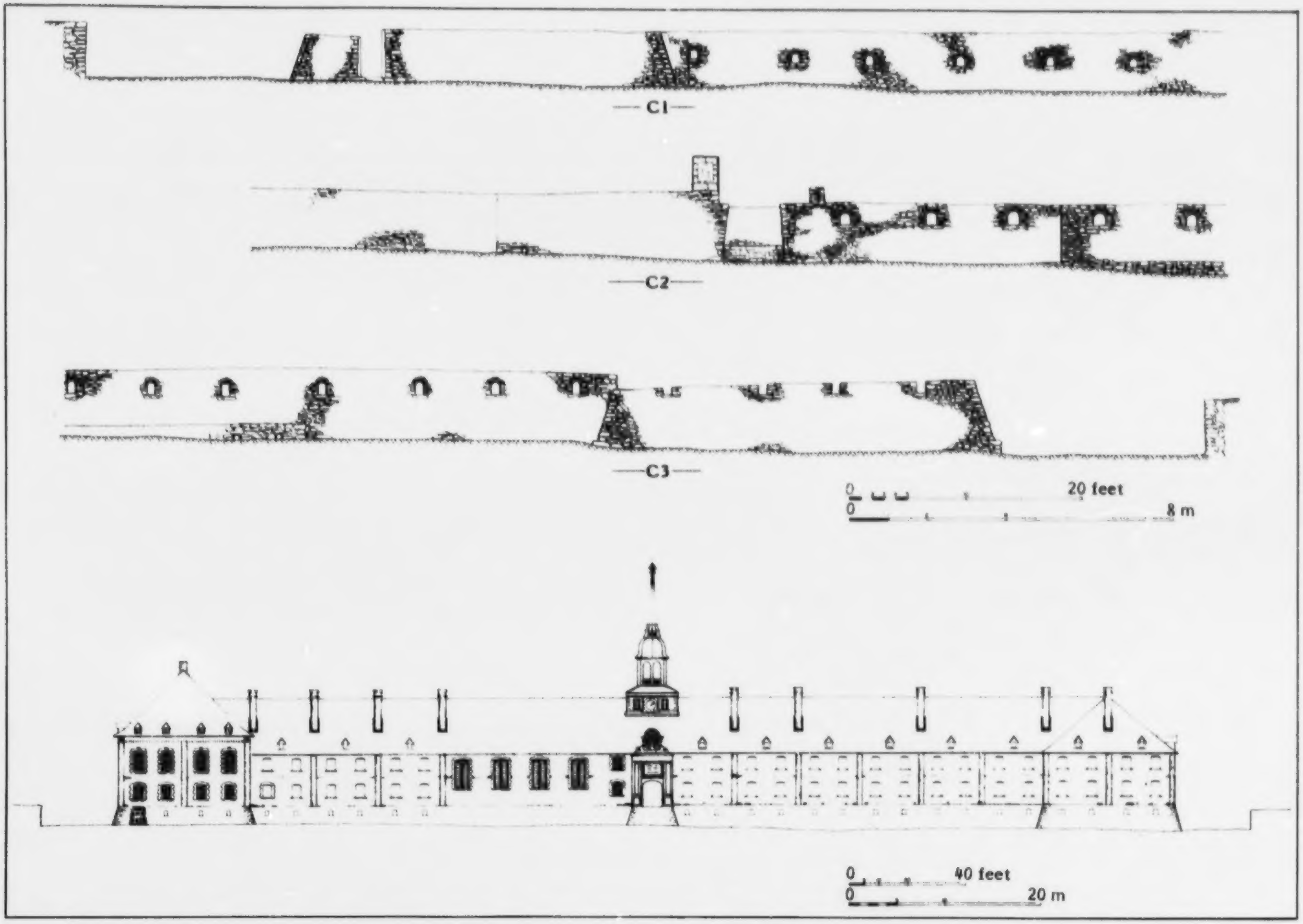
121 **King's Bastion**, key to sections. (Drawing by T.M. Smith.)


11.0m
10.0m
9.0m
8.0m
0
10
20 feet
0
10 m

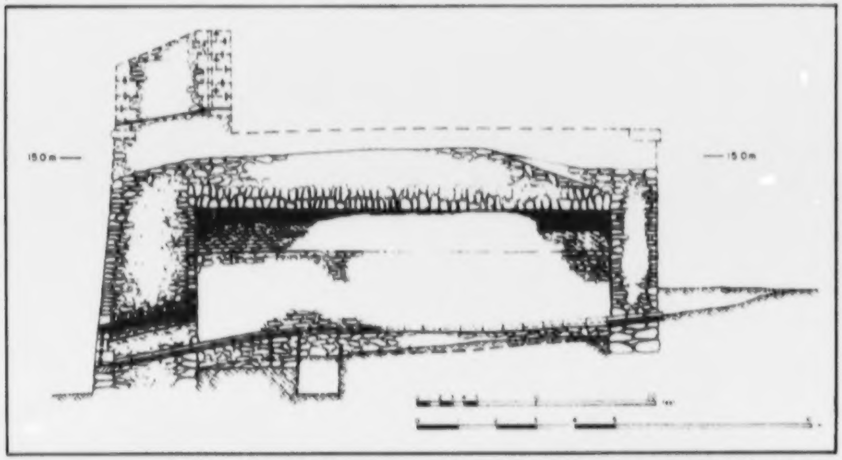
122 King's Bastion, section A-A. (Drawing by T.M. Smith.)


13m
8 m
0
20 feet
0
10 m

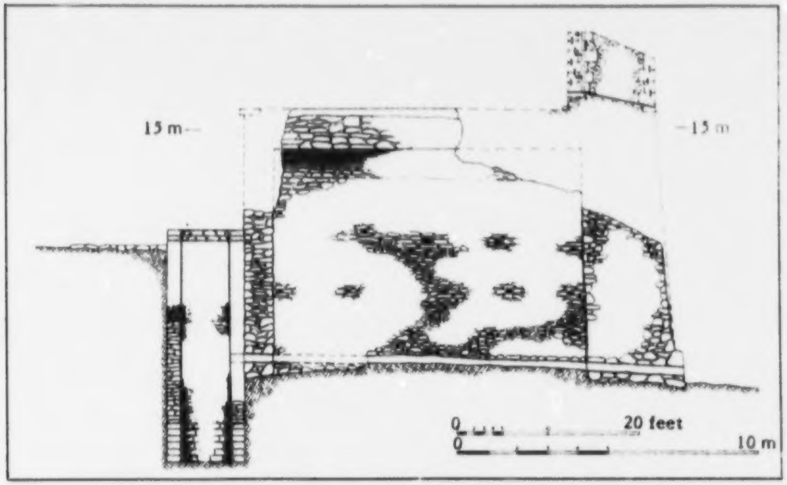
123 King's Bastion, section B-B. (Drawing by T.M. Smith.)


C1
C2
C3
0
20 feet
0
8 m
0
40 feet
0
20 m

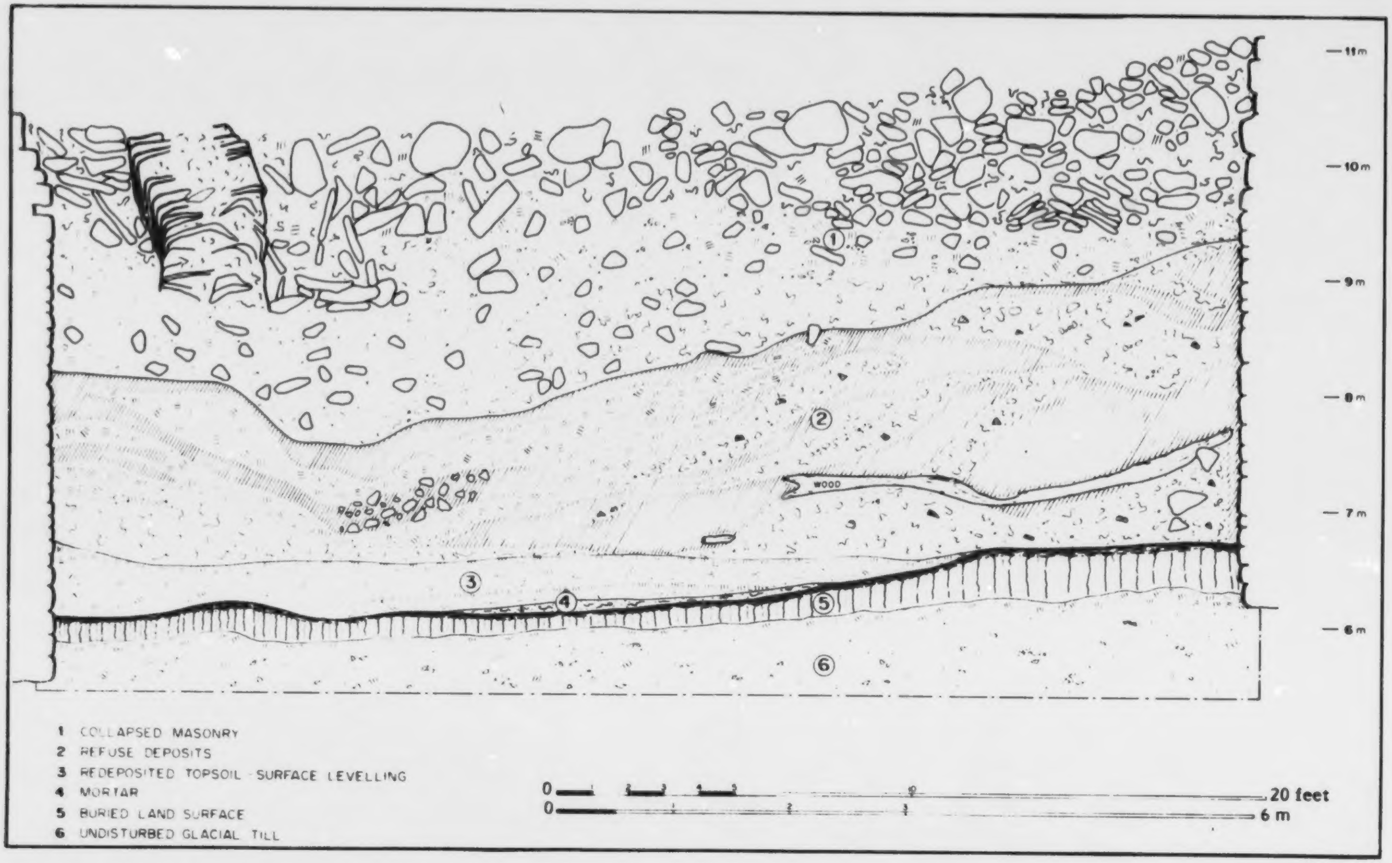
124 King's Bastion barracks, elevation C-C and conjectural elevation. (Drawing by T.M. Smith.)



125 **King's Bastion,** section D-D. (Drawing by T.M. Smith.)

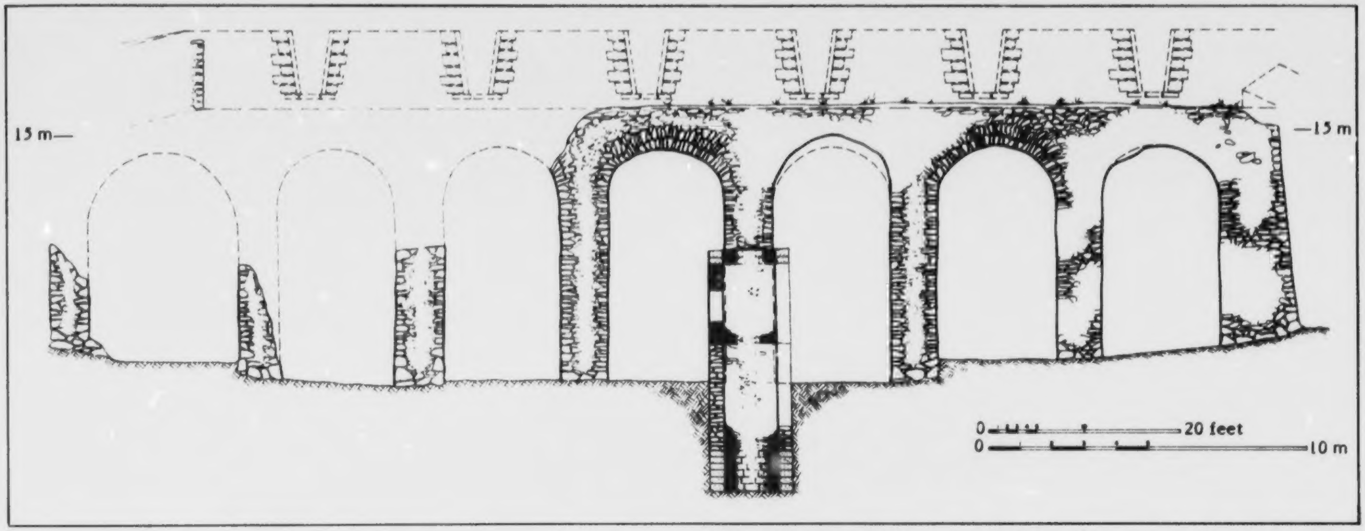

15 m
15 m
0
20 feet
0
10 m

126 **King's Bastion,** section E-E. (Drawing by T.M. Smith.)

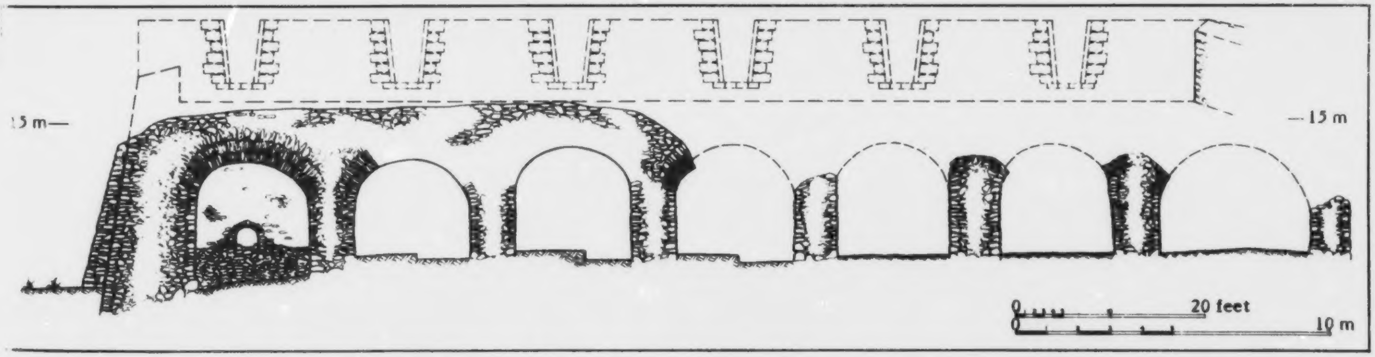


—11m
—10m
—9m
—8m
—7m
—6m
①
②
③
④
⑤
⑥
WOOD
1 COLLAPSED MASONRY
2 REFUSE DEPOSITS
3 REDEPOSITED TOPSOIL - SURFACE LEVELLING
4 MORTAR
5 BURIED LAND SURFACE
6 UNDISTURBED GLACIAL TILL
0 20 feet
0 6 m

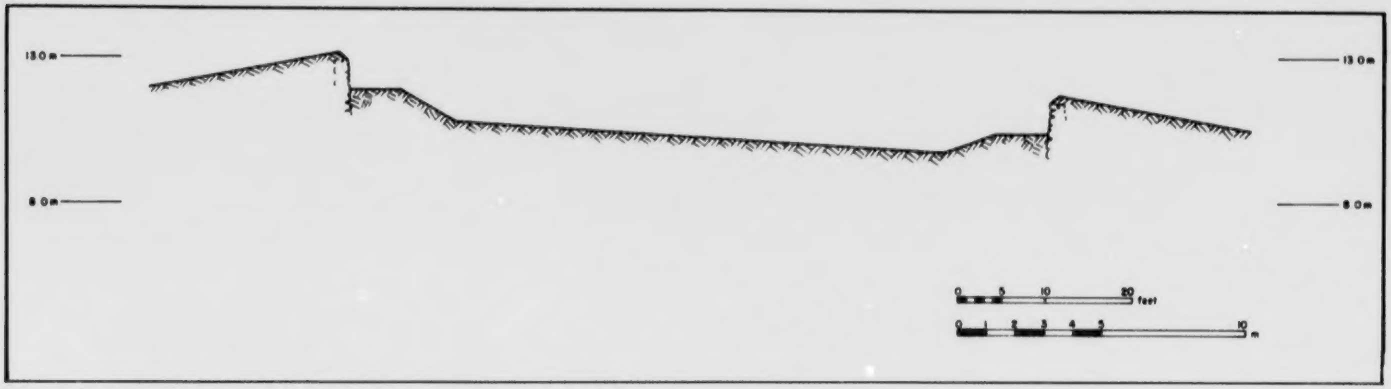
127 **King's Bastion,** casemate 5R. (Drawing by T.M. Smith.)


15 m—
—15 m
0
20 feet
0
10 m

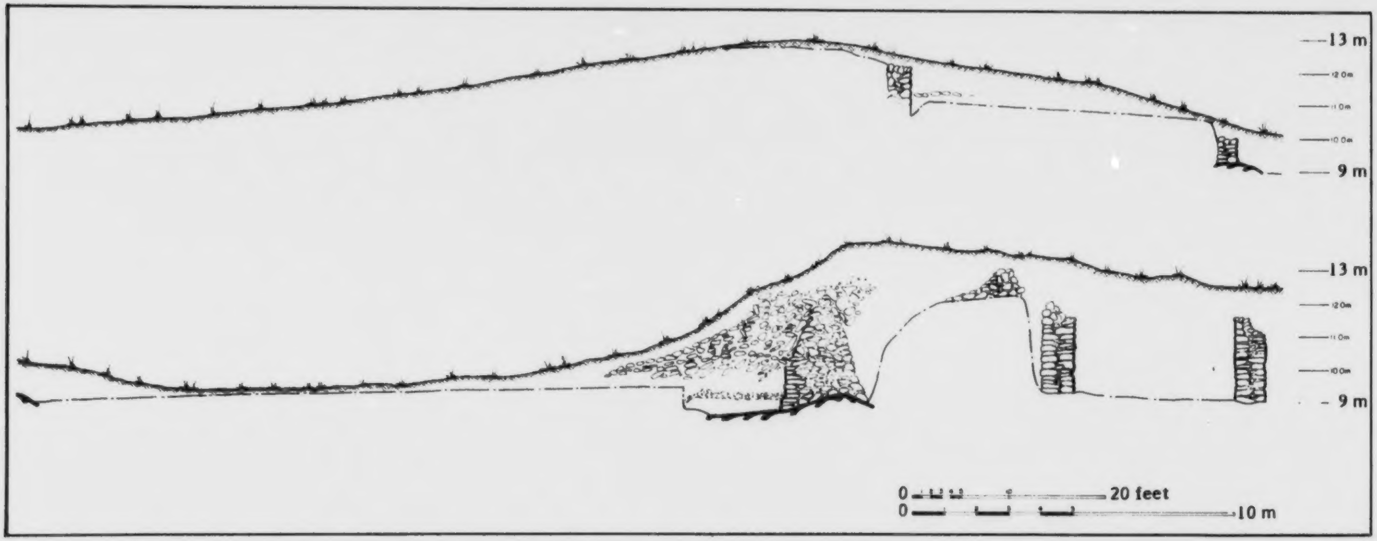
128 **King's Bastion,** section F-F. (Drawing by T.M. Smith.)


15 m—
—15 m
0
20 feet
0
10 m

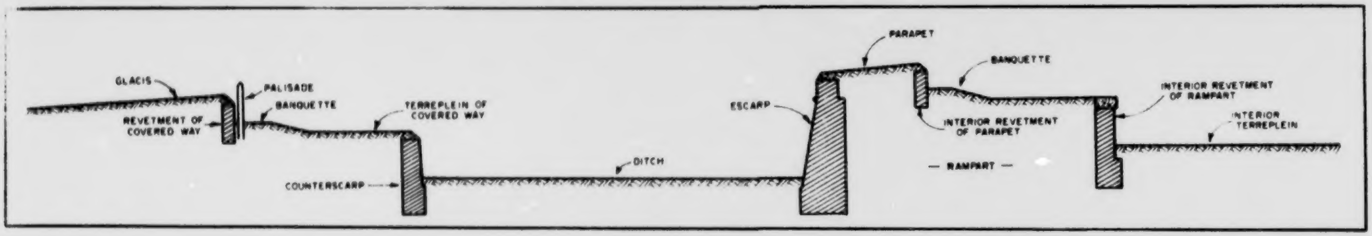
129 **King's Bastion,** section G-G. (Drawing by T.M. Smith.)


13.0m
8.0m
13.0m
8.0m
0 5 10 20 feet
0 1 2 3 4 5 10 m

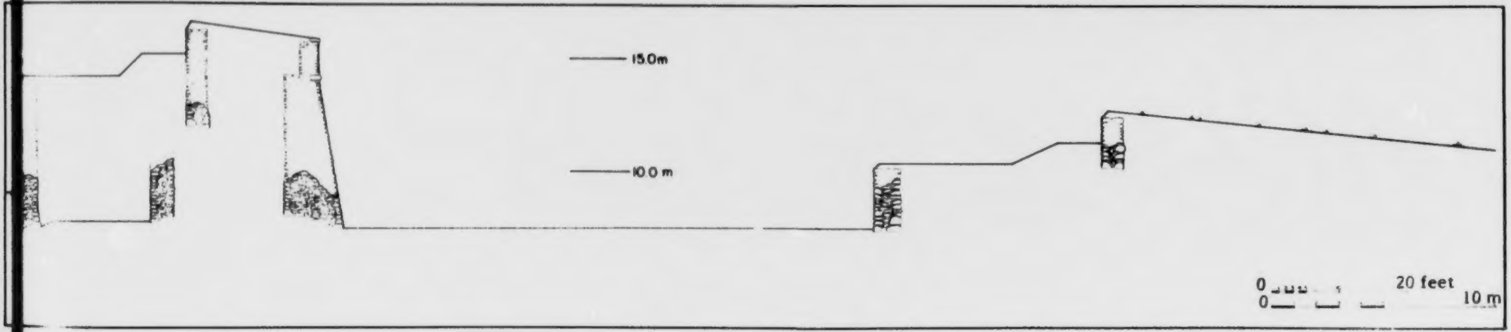
130 **King's Bastion**, section H-H. (Drawing by T.M. Smith.)


13 m
12.0m
11.0m
10.0m
9 m
13 m
12.0m
11.0m
10.0m
9 m
0 20 feet
0 10 m

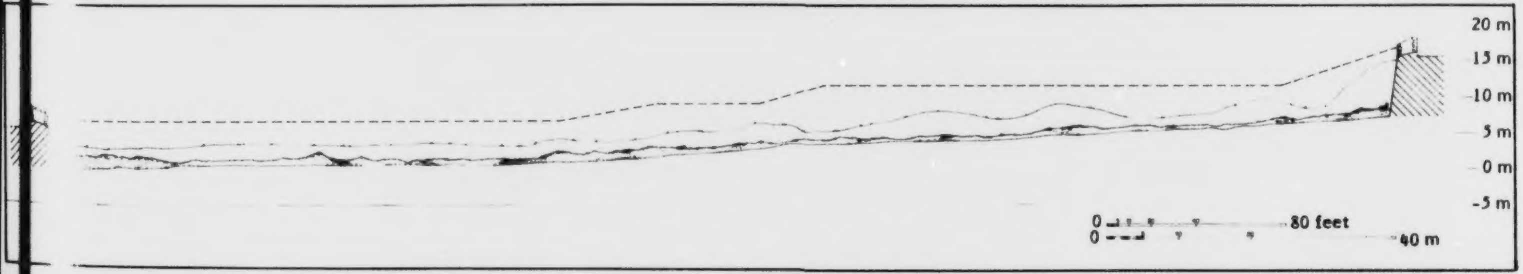
131 **King's Bastion**, section M-M. (Drawing by T.M. Smith.)


GLACIS
PALISADE
BANQUETTE
REVETMENT OF COVERED WAY
TERREPLEIN OF COVERED WAY
COUNTERSCARP
DITCH
ESCARP
PARAPET
BANQUETTE
INTERIOR REVETMENT OF PARAPET
RAMPART
INTERIOR REVETMENT OF RAMPART
INTERIOR TERREPLEIN

132 Typical section through fortification. (Drawing by T.M. Smith.)

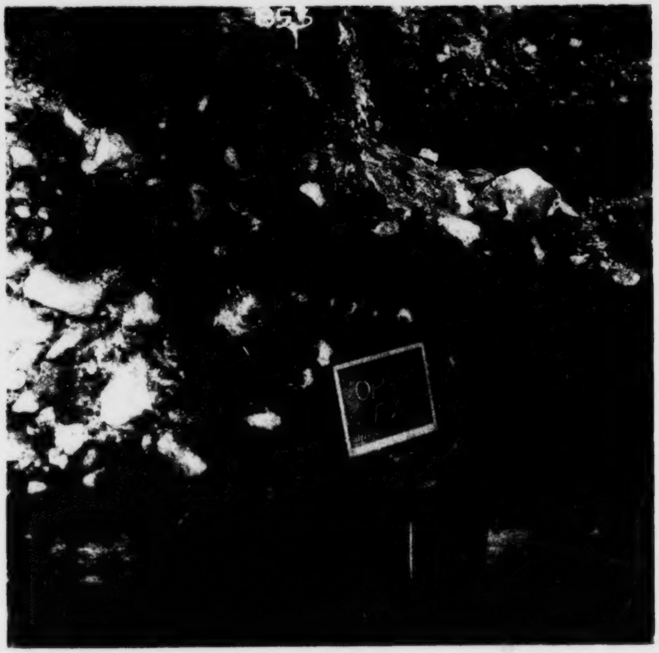

15.0m
10.0 m
0
20 feet
0
10 m

133 King's Bastion, parapet command of glacis, conjectural reconstruction. (Drawing by T.M. Smith.)

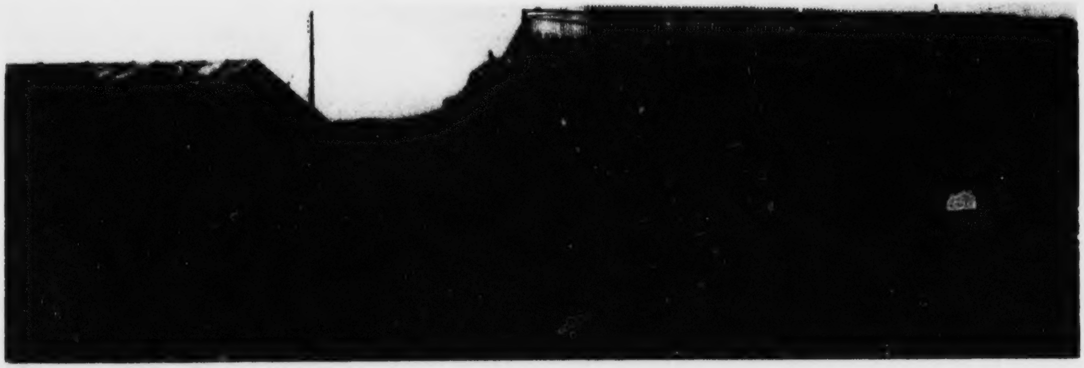

20 m
15 m
10 m
5 m
0 m
-5 m
0
80 feet
0
40 m

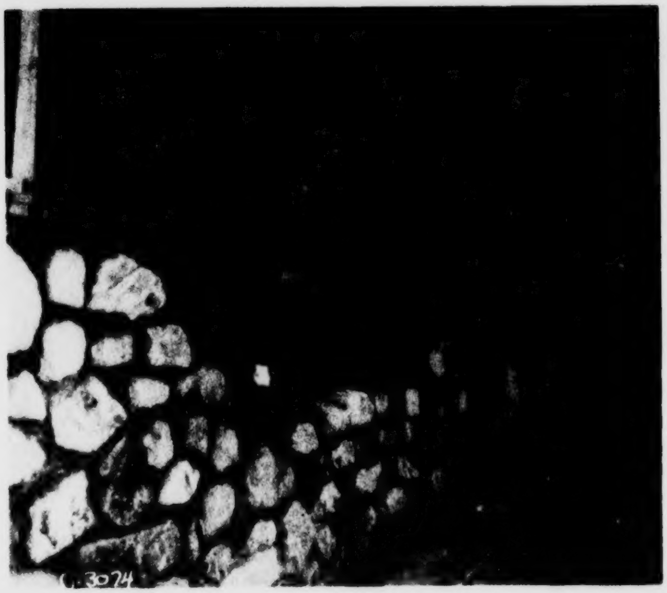
134 King's-Dauphin curtain, elevation J^1. (Drawing by T.M. Smith.)

135 King's Bastion. All that remained of the escarp and quoins in the left shoulder angle. (Fortress of Louisbourg NHP.)



136 King's Bastion. Left flank escarp after excavation; drain in re-entrant angle at right. The extent of early 20th-century stabilization attempts are visible as darker masonry below fencing and dipping toward top of drain. (Fortress of Louisbourg NHP.)





137 King's Bastion, old and new. Solid and well-preserved original casemate arches and partitions at rear; reconstructed left flank escarp nears completion in front. (Fortress of Louisbourg NHP.)

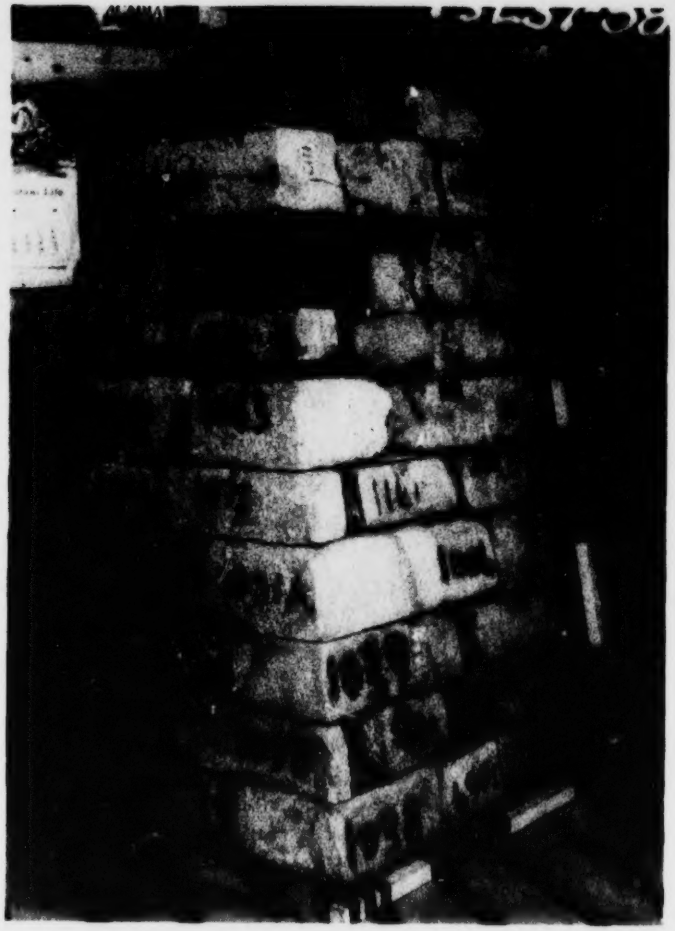
138 King's Bastion. Emergency measures for defence: turf and fascine revetment placed against left flank escarp (extreme left) in 1757. Rubble-stone drain installed during 1900s stabilization work is immediately above scale at right. (Fortress of Louisbourg NHP.)

139 King's Bastion. Right flank escarp: remains of the wall rebuilt in 1755. Note use of dressed stones as plinth to receive timber uprights. (Fortress of Louisbourg NHP.)

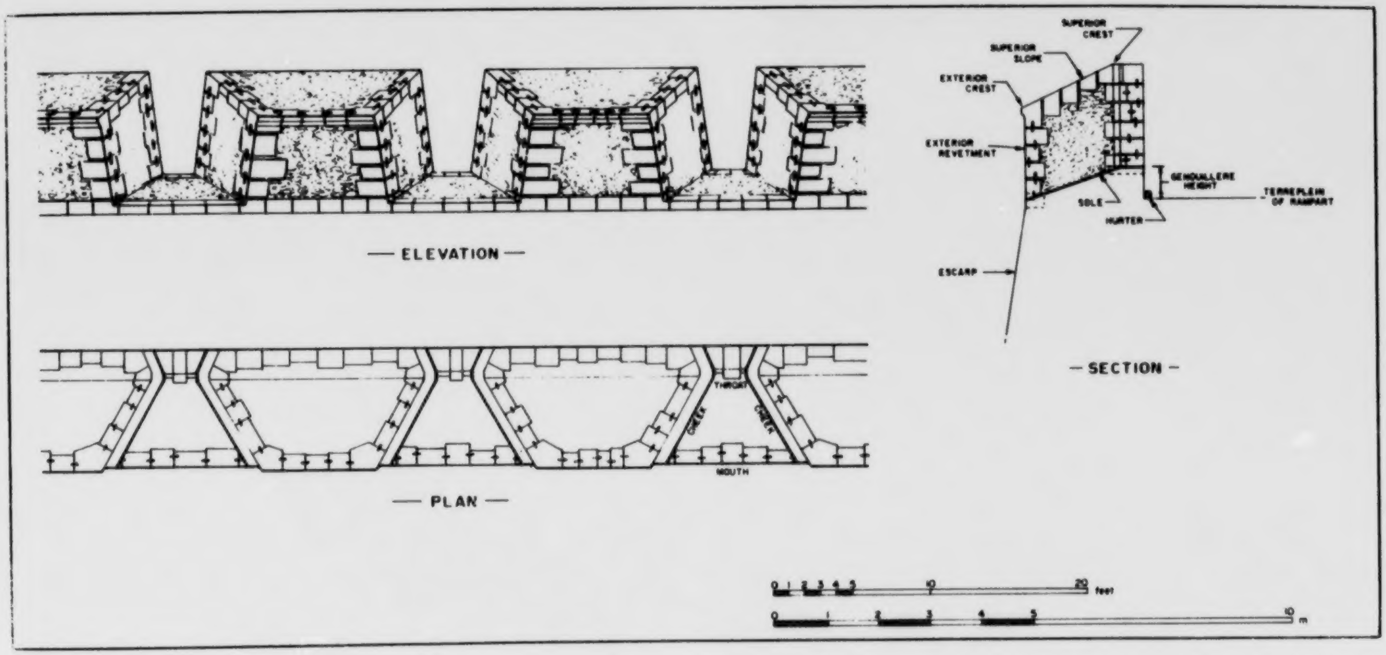
140 King's Bastion. Right flank escarp. Junction between 1755 wall and original base is shown by difference in masonry colour and texture. (Fortress of Louisbourg NHP.)

141 King's Bastion. Right flank escarp: dressed sandstone quoins, seen in profile (immediately to right of range-pole). Quoins date to original 1720 construction prior to addition of curtain wall. (Fortress of Louisbourg NHP.)

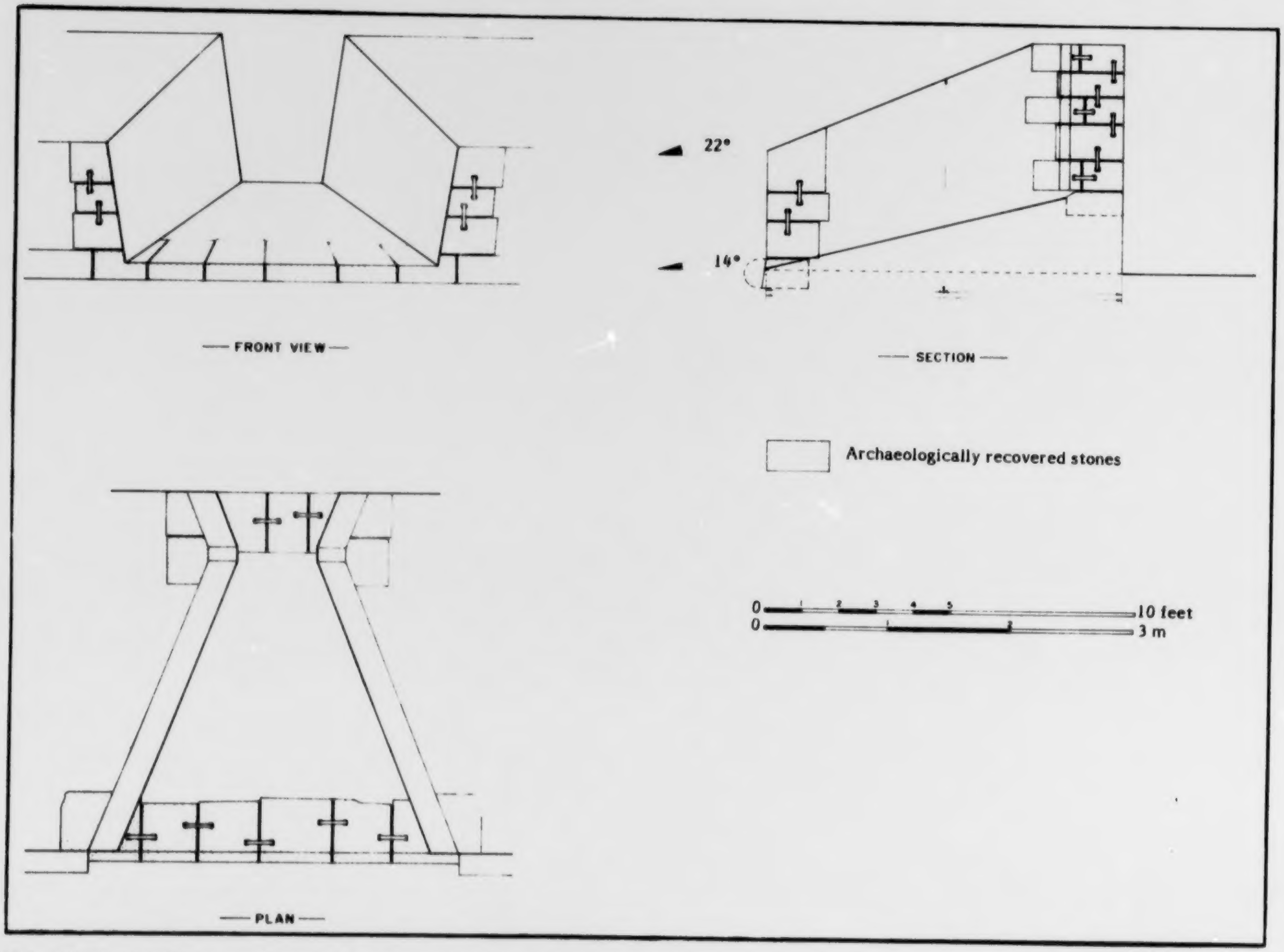
142 King's Bastion. Right re-entrant angle: surviving section of postern tunnel, parallel and keyed to terminating wall of flank. At right, remaining quoins from original angle when bastion was a free-standing redoubt. Above, rear of parapet of King's-Dauphin curtain. (Fortress of Louisbourg NHP.)



143 King's Bastion. Re-assembled angle at rear of right flank. (Fortress of Louisbourg NHP.)

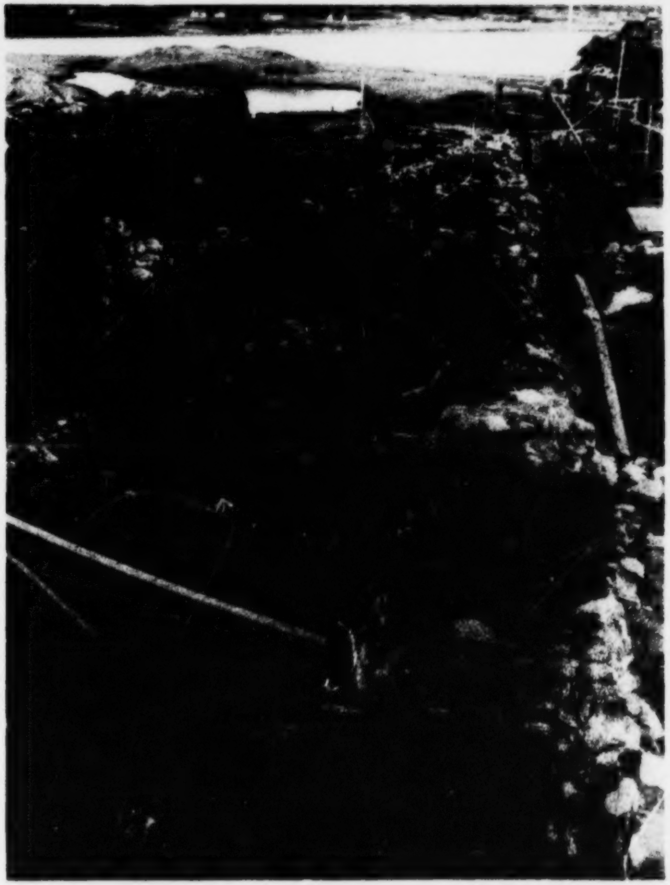

SUPERIOR CREST
SUPERIOR SLOPE
EXTERIOR CREST
EXTERIOR REVETMENT
GENOUILLERE HEIGHT
TERREPLEIN OF RAMPART
SOLE
HURTER
ESCARP
— ELEVATION —
THROAT
CHEEK
CHEEK
MOUTH
— PLAN —
— SECTION —
0 1 2 3 4 5 10 20 feet
0 1 2 3 4 5 10 m

144 Typical parapet with embrasures. (Drawing by T.M. Smith.)


22°
14°
— FRONT VIEW —
— SECTION —
Archaeologically recovered stones
0 1 2 3 4 5 10 feet
0 1 2 3 m
— PLAN —

145 King's Bastion, conjectural re-assembly of right flank embrasures. (Drawing by T.M. Smith.)

146 King's Bastion postern. When removed and examined, sill and jamb stones proved to have been reworked. (Fortress of Louisbourg NHP.)

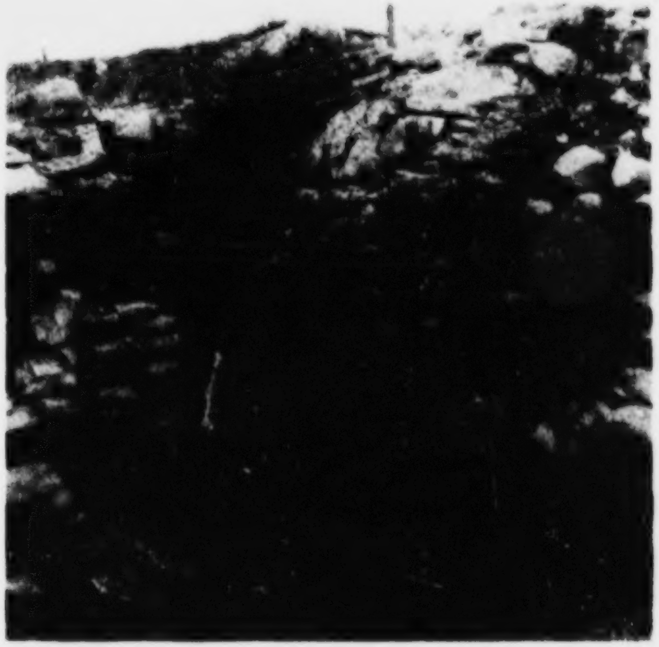


147 King's Bastion. Right face casemates, looking north towards Dauphin Bastion (low mound beyond pond, upper left). Note remains of interior revetment of parapet in rampart fill at left. (Fortress of Louisbourg NHP.)

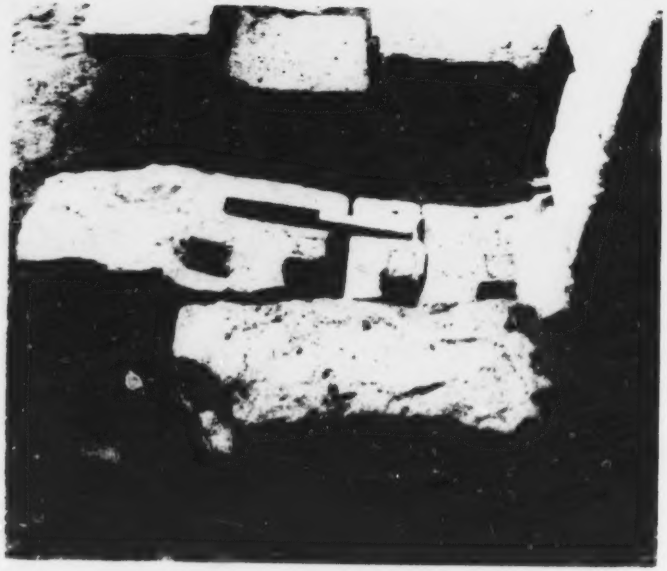
148 King's Bastion. Right face casemate 8R: cobble floor and drainage channels. (Fortress of Louisbourg NHP.)

149 King's Bastion. Right flank casemate: doorway surround. (Fortress of Louisbourg NHP.)

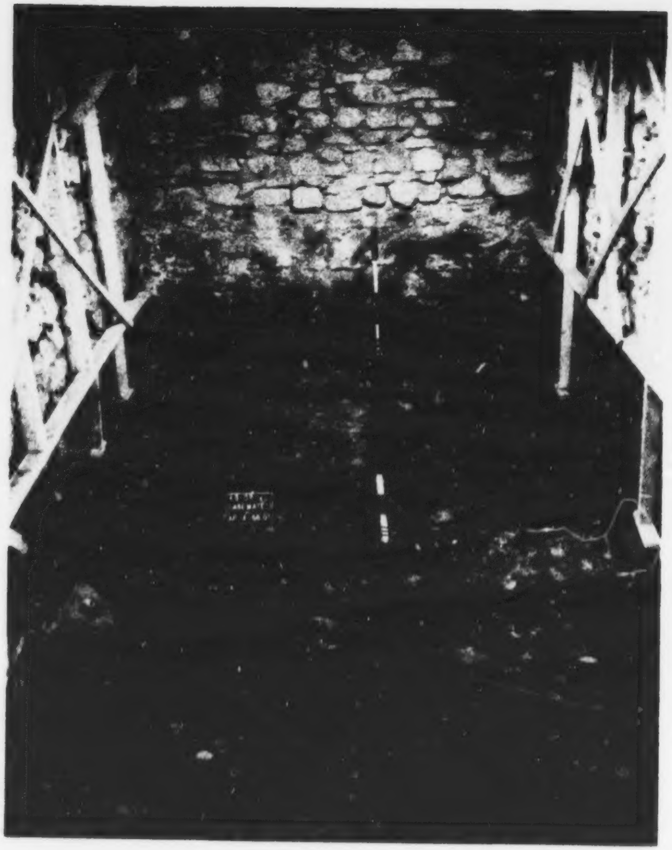
150 **King's Bastion.** Casemate 7R: remains of drain passing through escarp at rear of casemate. (Fortress of Louisbourg NHP.)



151 **King's Bastion.** Casemate 6L: doorway and vents with flat sandstone surrounds, as seen from terreplein of bastion. Note junction with interior revetment of left face (at right). (Fortress of Louisbourg NHP.)



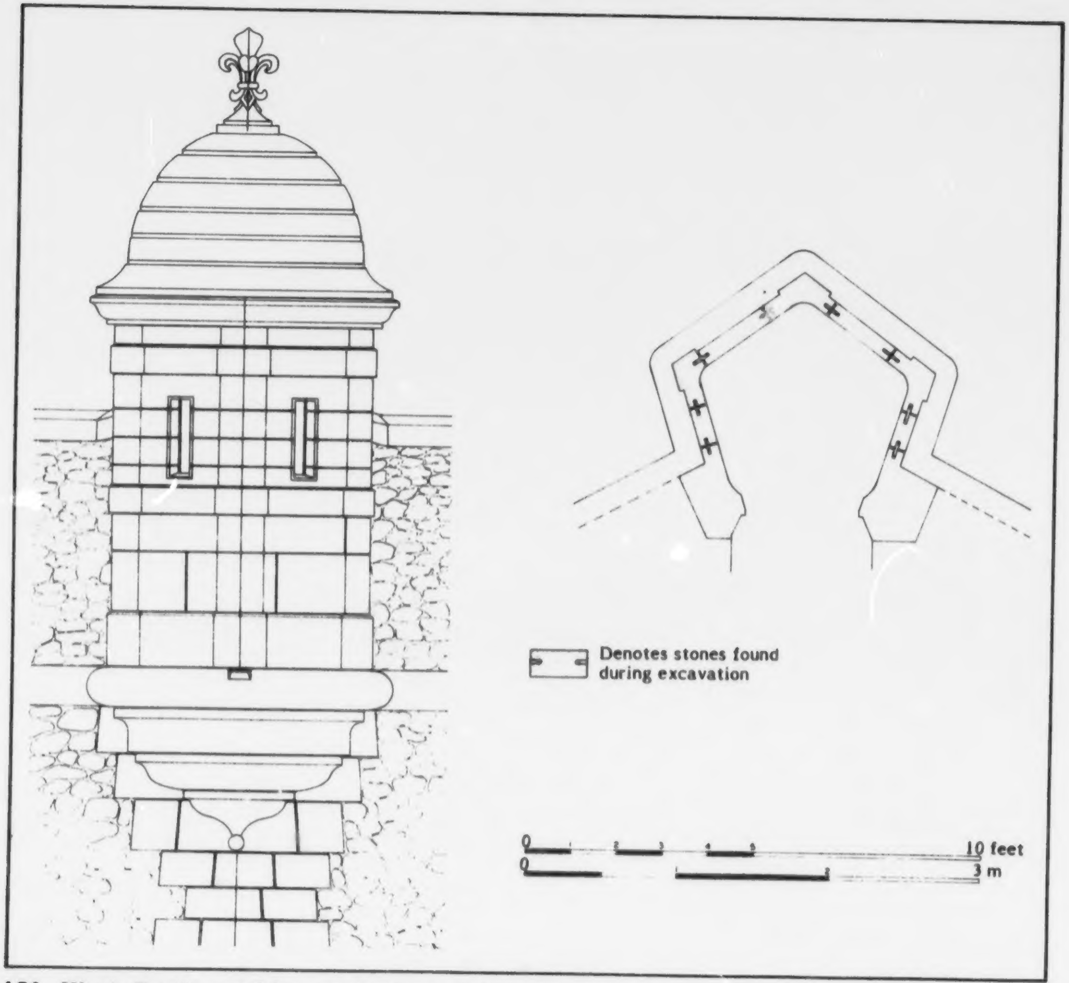
152 King's Bastion. Dressed stones forming surround of drain opening, recovered from rebuilt right flank escarp; damaged lintel in foreground. Note square holes to receive iron grille. (Fortress of Louisbourg NHP.)



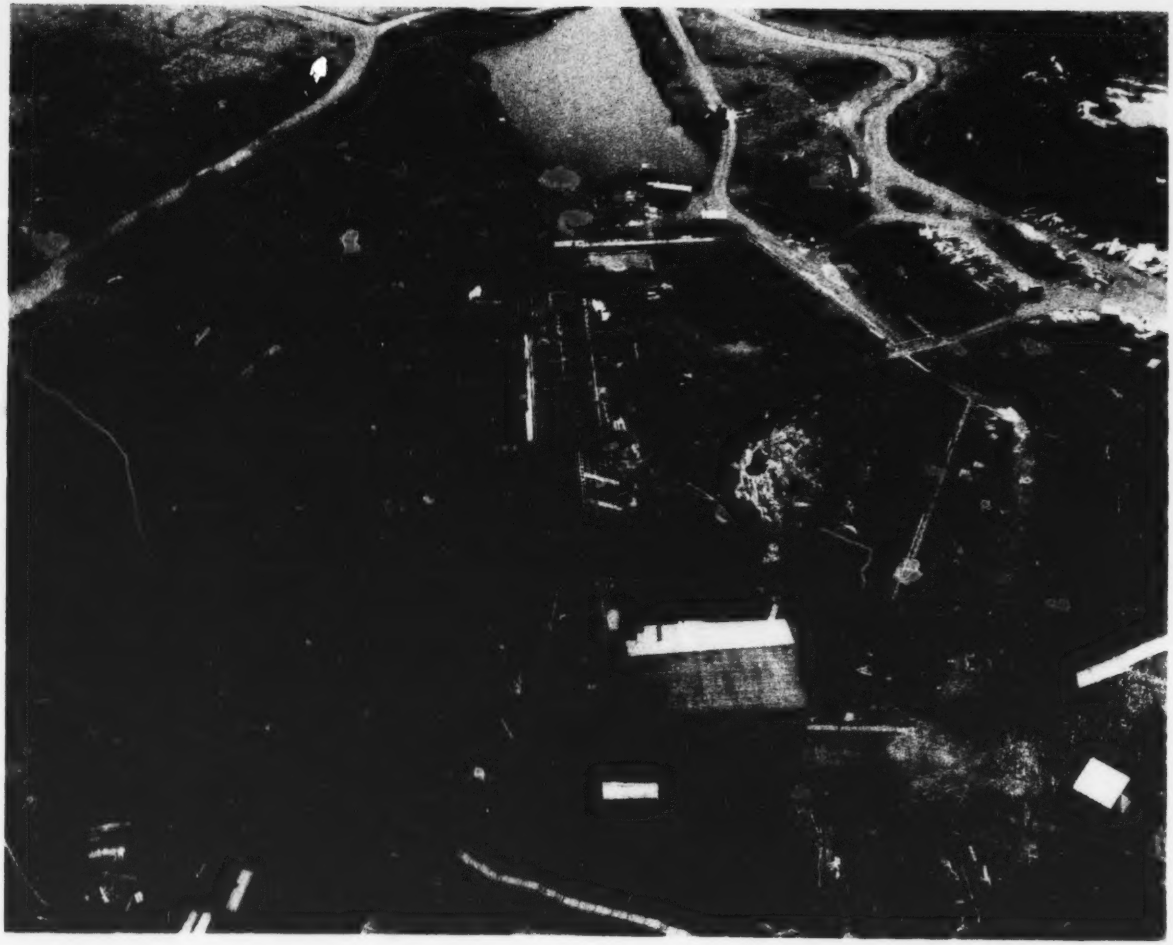
153 King's Bastion. Casemate 1R: remains of wooden floor. (Fortress of Louisbourg NHP.)

154 King's Bastion. Right-flank casemates: ashlar paving blocks from terreplein of rampart. (Fortress of Louisbourg NHP.)

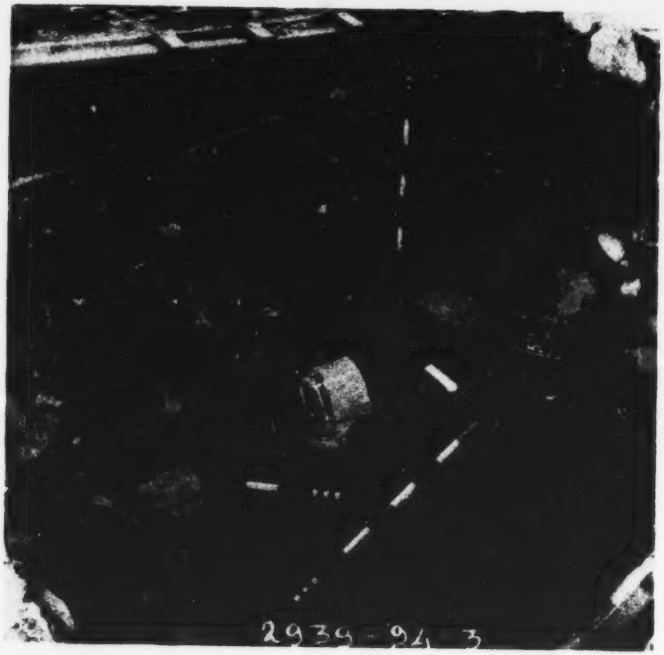
155 Brouage (Charente-Maritime). *Guérites* on the ramparts. (Photo by author.)


Denotes stones found during excavation
0
10 feet
0
3 m

156 King's Bastion *guérite*, conjectural model. (Drawing by T.M. Smith.)

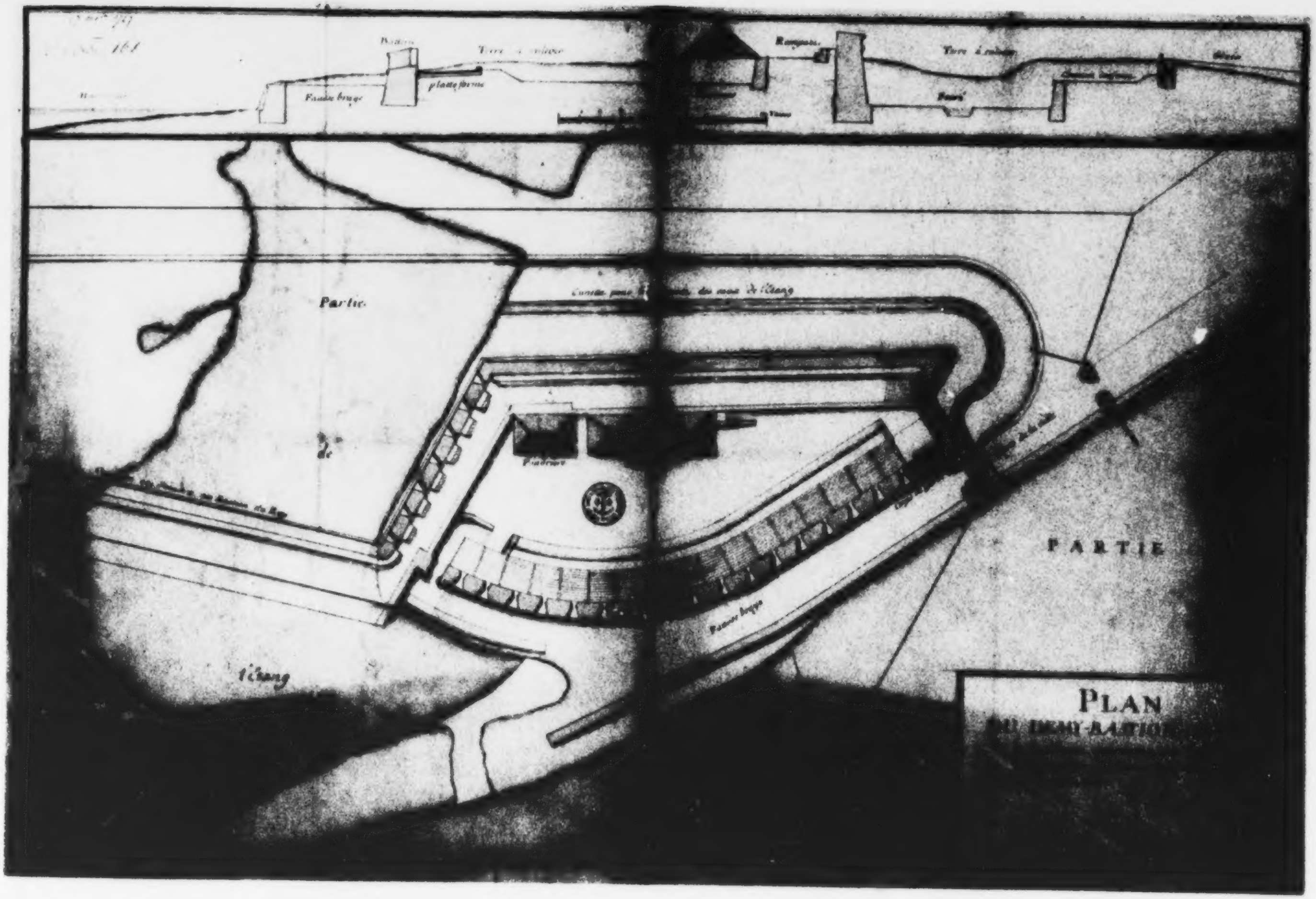


157 Citadel. Aerial view during excavation of townside *place d'armes* (centre left). Construction of barracks and escarps is in progress. (Fortress of Louisbourg NHP.)

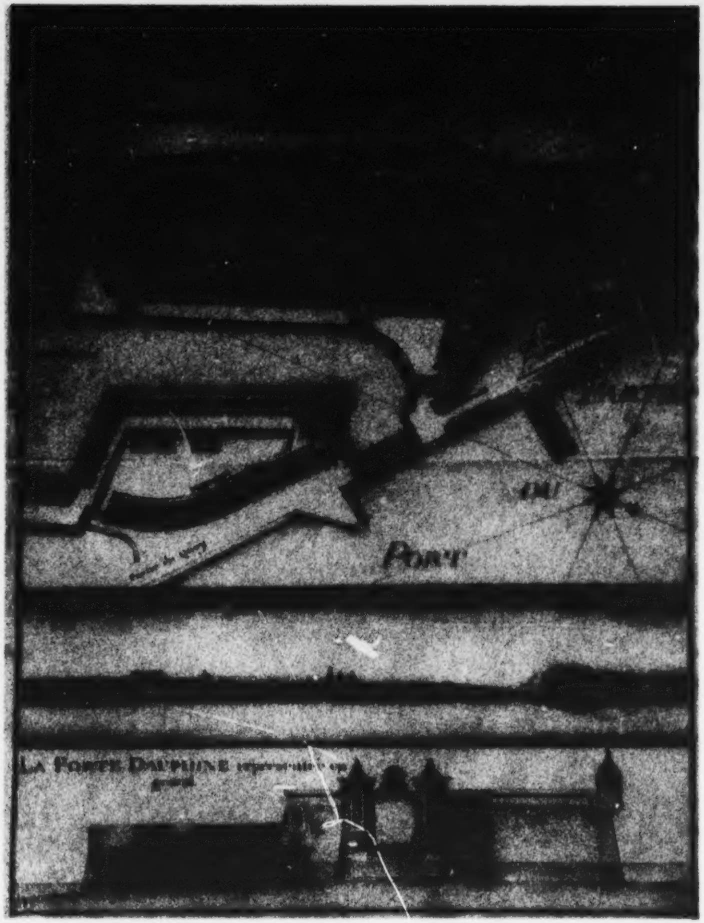


158 King's Bastion barracks. Rubble of collapsed structure in basement below level of 1930s stabilization work (roughly at level of top of vertical scale). Numbered blocks of dressed sandstones are from fireplace and window surrounds. (Fortress of Louisbourg NHP.)

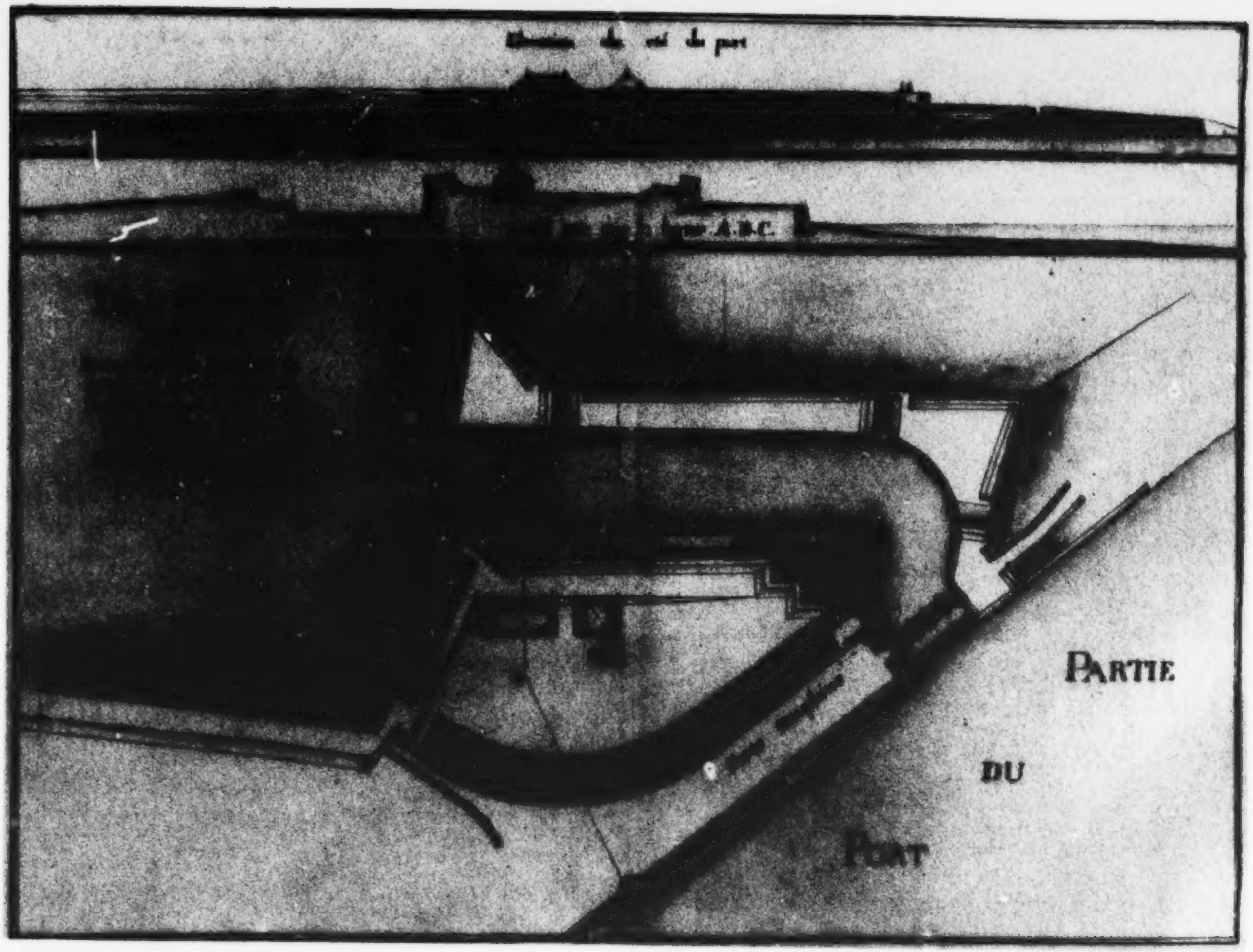
159 Citadel. Townside *place d'armes:* post-moulds of palisade posts set in banquette immediately behind interior revetment. (Fortress of Louisbourg NHP.)


Fausse braye
platte forme
Partie
PARTIE
Fausse braye
l'Etang
PLAN
DU DEMY-BASTION

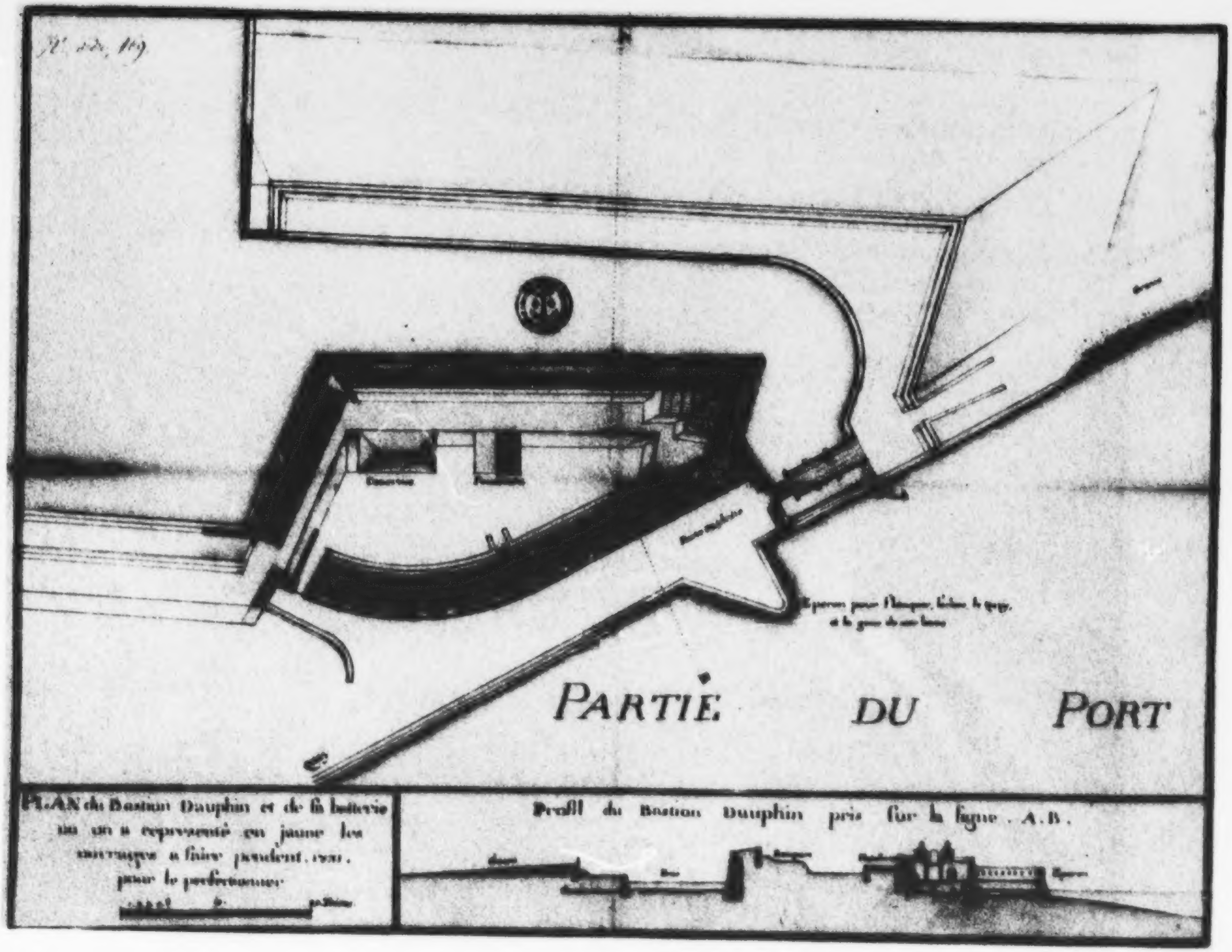
160 Dauphin Bastion. Early construction proposals, Verrier, 1727. Not followed in detail. (Archives Nationales, Paris.)



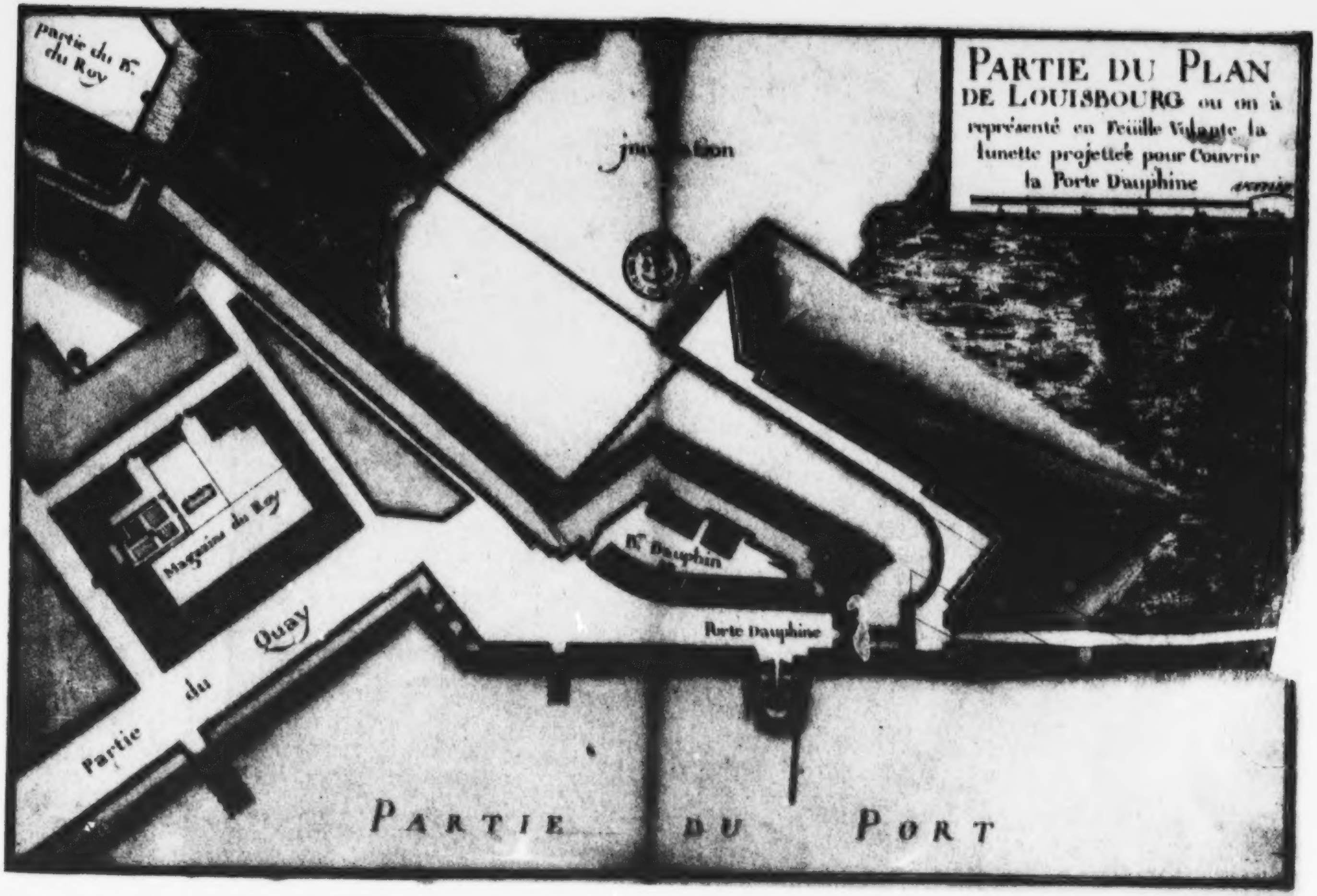
161 **Dauphin Bastion.** Unsigned, undated plan and view. Circular Battery is shown with 17 embrasures and interior revetment of masonry; the entrance through the battery is depicted at left in the general view. The *éperon* and quay wall are shown as faced in ashlar. Note section through *batardeau* and sluice (below); representation of gate is identical to a larger, dated drawing (Fig. 166). (Archives du Génie, Vincennes.)



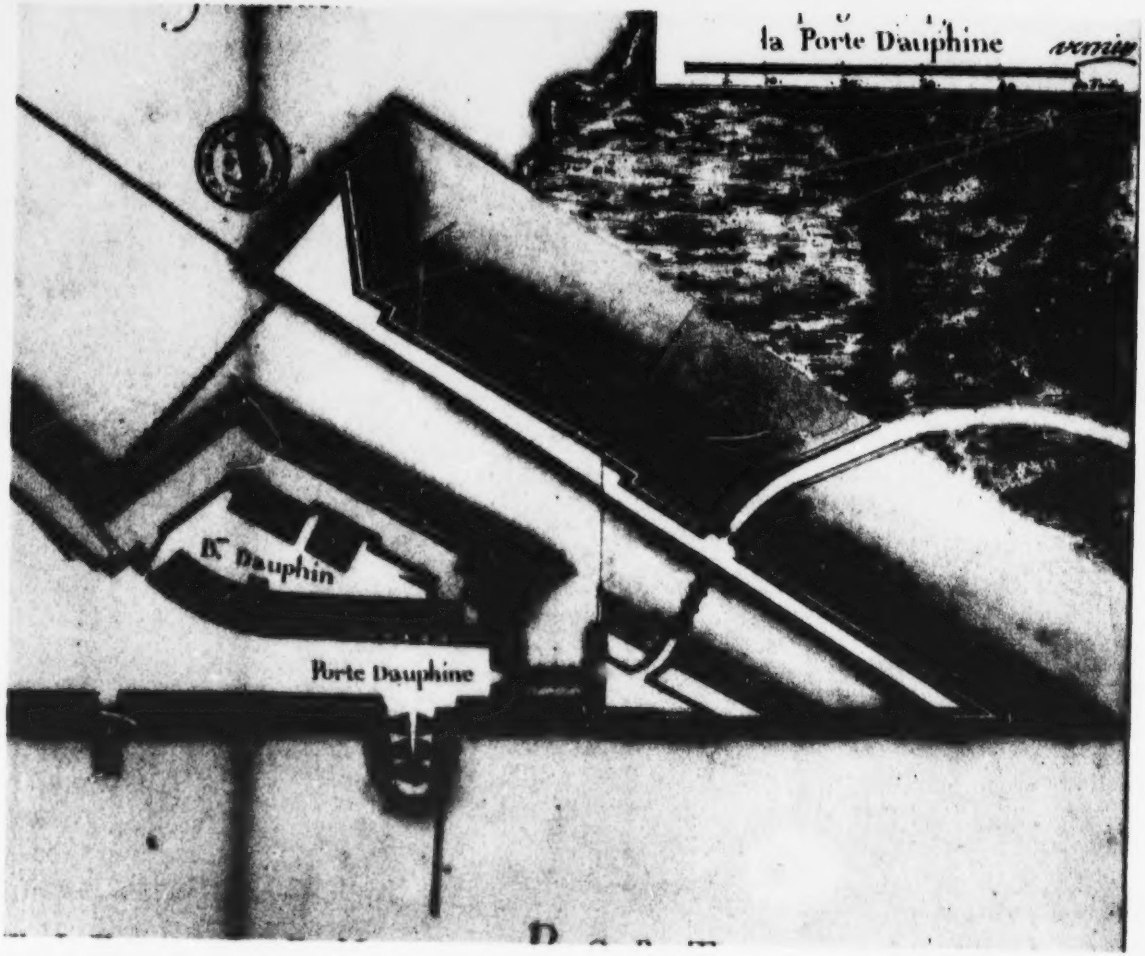
162 Dauphin Bastion. Undated, unsigned plan. Circular Battery is shown with 16 embrasures and interior slope of earth. Note gradual diminishing on interior slope of left face the nearer it is to flanked angle. No *éperon* is shown. (Bibliothèque Nationale, Paris.)


PARTIE DU PORT
PLAN du Bastion Dauphin et de ſa batterie
Profil du Bastion Dauphin pris ſur la ligne . A.B .

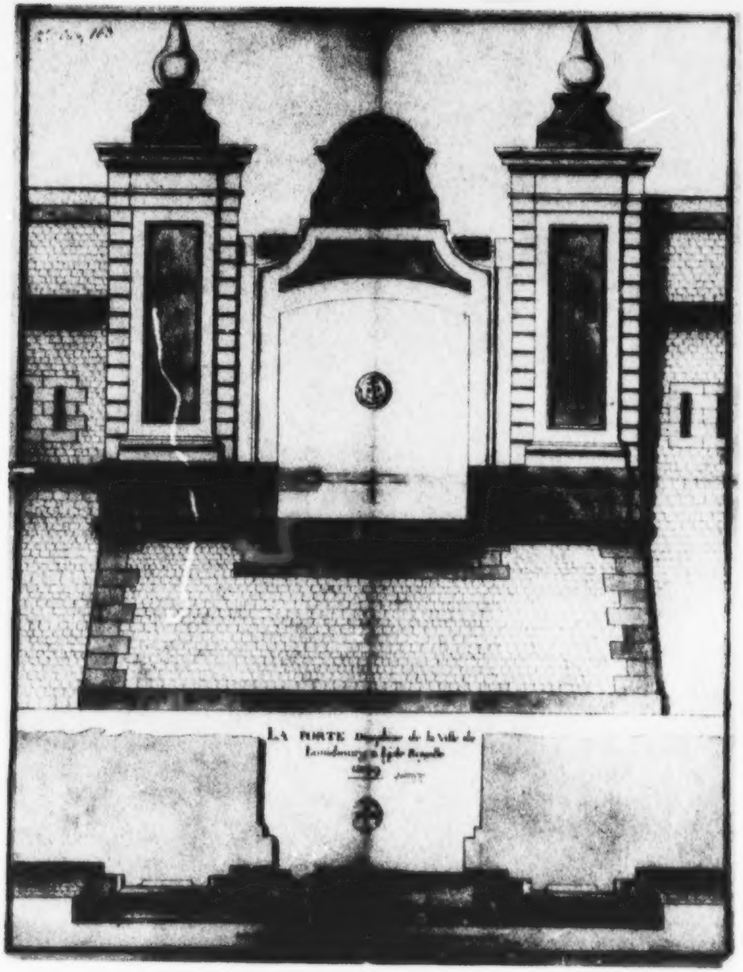
163 Dauphin Bastion. Construction proposals for 1731. Circular Battery is shown with 17 embrasures and masonry interior revetment (indicated as work to be done). (Archives Nationales, Paris.)


PARTIE DU PLAN DE LOUISBOURG ou on à représenté en Feüille Volante la lunette projettée pour Couvrir la Porte Dauphine
Partie du Bt. du Roy
Magazins du Roy
Bt. Dauphin
Porte Dauphine
Partie du Quay
PARTIE DU PORT

164 Dauphin Bastion. Proposal to modify glacis in front of gate, Verrier, undated (1744). Ramparts, including *éperon*, are represented in their completed state; Circular Battery has 16 embrasures. (Archives Nationales, Paris.)


la Porte Dauphine
B.n Dauphin
Porte Dauphine

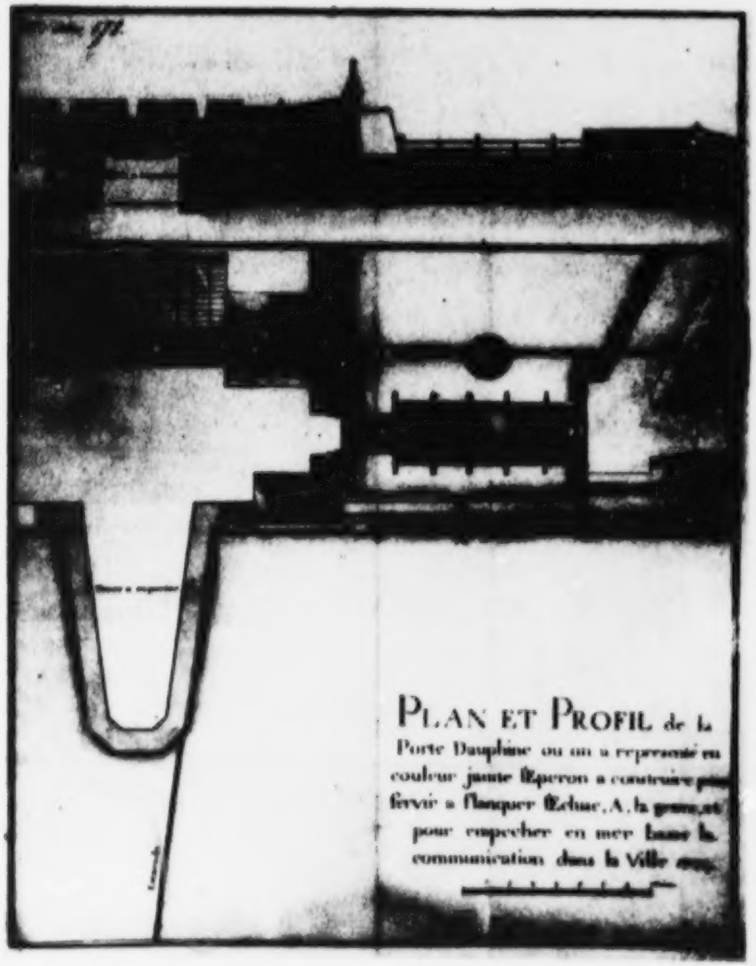
165 Dauphin Bastion. Figure 164 with foldaway flap down to show proposed lunette in front of gate. (Archives Nationales, Paris.)



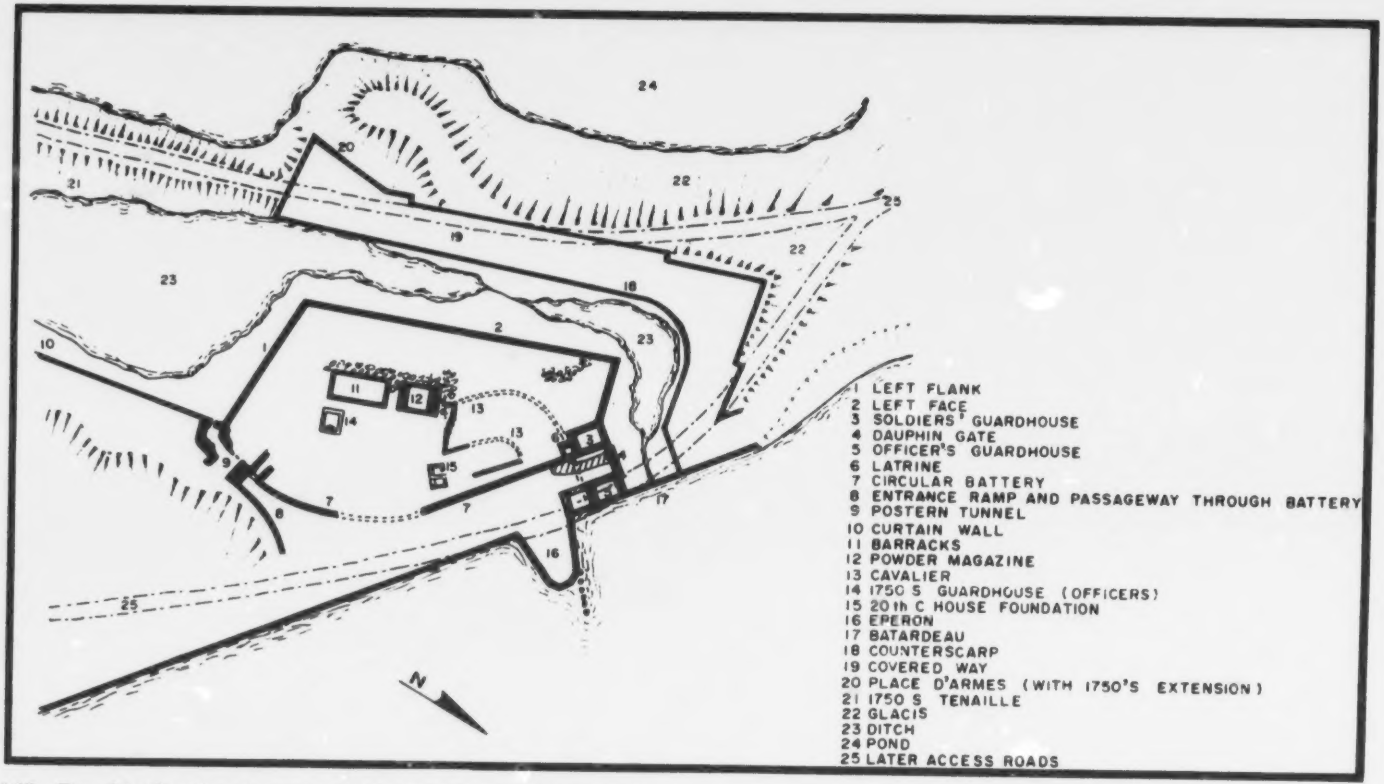
LA PORTE Dauphine de la ville de

166 Dauphin Gate. Preliminary design, Verrier, 1729. (Archives Nationales, Paris.)

167 Dauphin Gate. Revised design, 1733. Useful for sections through Circular Battery and *batardeau;* also plan of guardhouses. (Archives Nationales, Paris.)

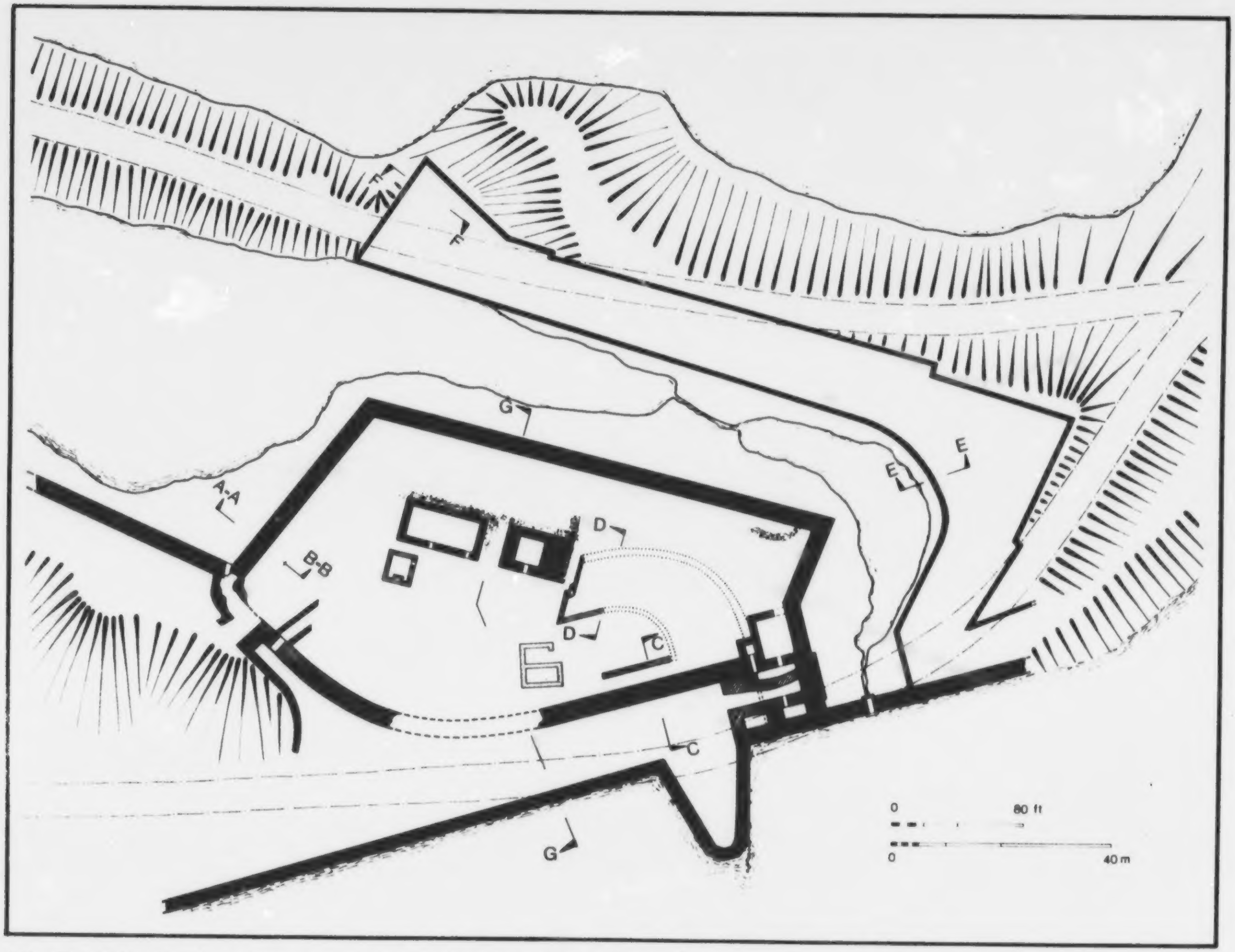

PLAN ET PROFIL de la
Porte Dauphine ou on a representé en
couleur jaune l'Eperon a construire pour
ſervir a flanquer l'Echuse, A, la gorge, et
pour empecher en mer la
communication dans la Ville

168 Dauphin Gate. Construction of *éperon*, 1734. Note extensive use of plank revetting although *batardeau* is faced in ashlar. Note also outlet for latrine drain at right of *éperon*. (Archives Nationales, Paris.)

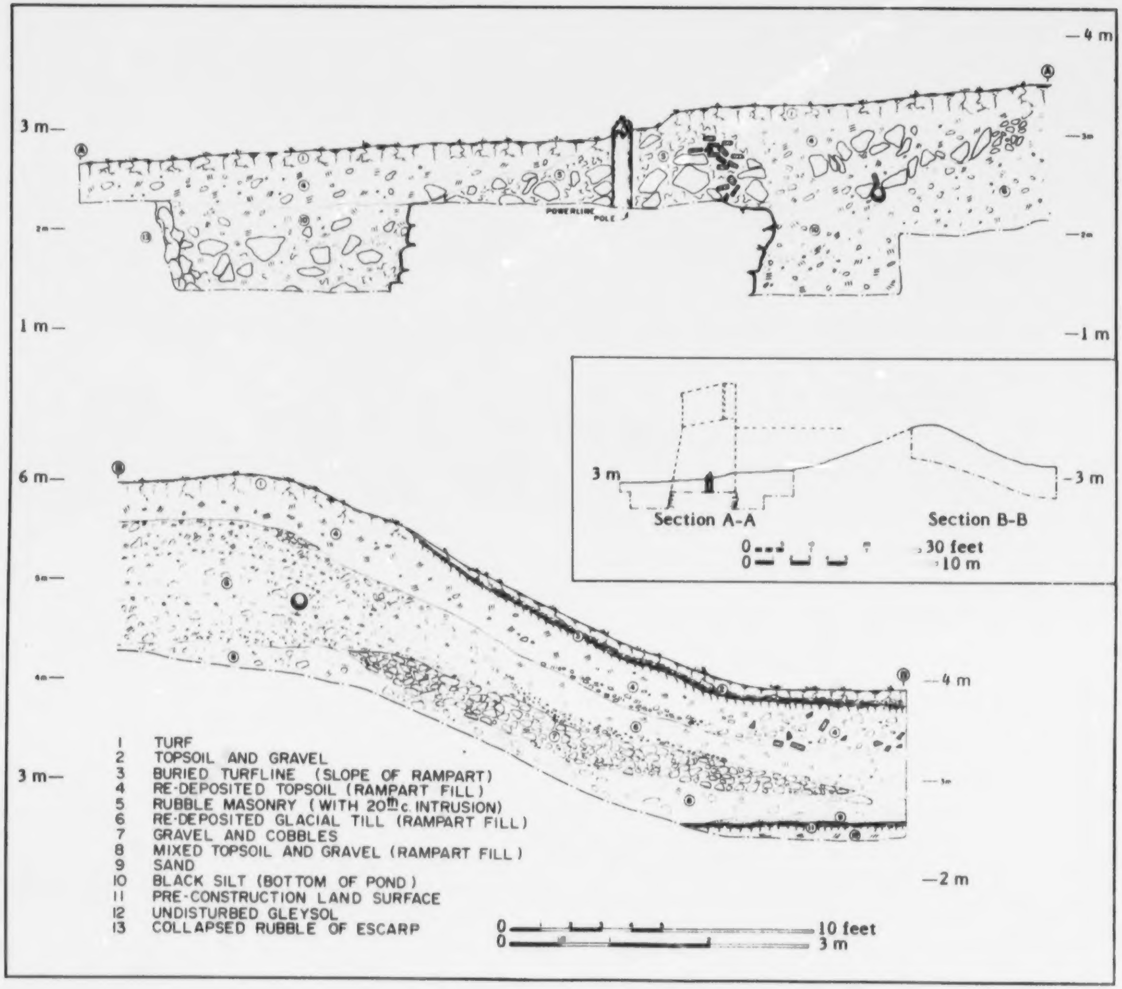

1 LEFT FLANK
2 LEFT FACE
3 SOLDIERS' GUARDHOUSE
4 DAUPHIN GATE
5 OFFICER'S GUARDHOUSE
6 LATRINE
7 CIRCULAR BATTERY
8 ENTRANCE RAMP AND PASSAGEWAY THROUGH BATTERY
9 POSTERN TUNNEL
10 CURTAIN WALL
11 BARRACKS
12 POWDER MAGAZINE
13 CAVALIER
14 1750 S GUARDHOUSE (OFFICERS)
15 20th C HOUSE FOUNDATION
16 EPERON
17 BATARDEAU
18 COUNTERSCARP
19 COVERED WAY
20 PLACE D'ARMES (WITH 1750'S EXTENSION)
21 1750 S TENAILLE
22 GLACIS
23 DITCH
24 POND
25 LATER ACCESS ROADS
N

169 Dauphin Bastion: key to principal features. (Drawing by T.M. Smith.)

170 Dauphin Bastion. Initial stages of excavation. View is taken from covered way towards left flank; plastic shelter at far right is location of re-entrant angle. Two crew members in raft (centre right) are attempting to place intake of 6-inch pump (centre left) in clear water as opposed to mud. (Fortress of Louisbourg NHP.)

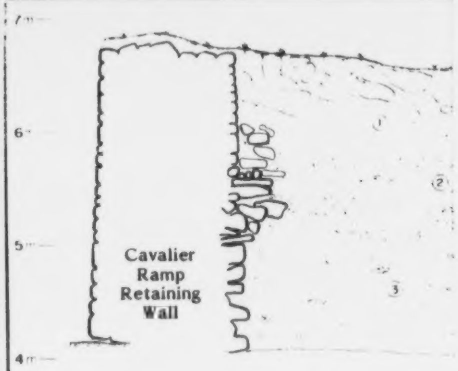

F
F
G
E
E
A-A
B-B
D
D
C
6
C
G
0
80 ft
0
40 m

171 Dauphin Bastion: key to sections. (Drawing by T.M. Smith.)



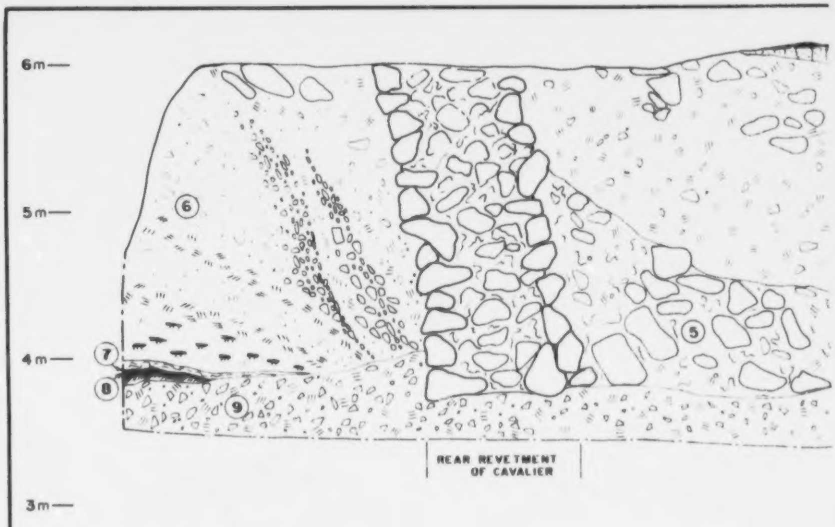
— 4 m
3 m —
— 3 m
2 m —
— 2 m
1 m —
— 1 m
POWERLINE POLE
Section A-A
Section B-B
0 30 feet
0 10 m
6 m —
5 m —
4 m —
— 4 m
3 m —
— 3 m
— 2 m
1 TURF
2 TOPSOIL AND GRAVEL
3 BURIED TURFLINE (SLOPE OF RAMPART)
4 RE-DEPOSITED TOPSOIL (RAMPART FILL)
5 RUBBLE MASONRY (WITH 20th c. INTRUSION)
6 RE-DEPOSITED GLACIAL TILL (RAMPART FILL)
7 GRAVEL AND COBBLES
8 MIXED TOPSOIL AND GRAVEL (RAMPART FILL)
9 SAND
10 BLACK SILT (BOTTOM OF POND)
11 PRE-CONSTRUCTION LAND SURFACE
12 UNDISTURBED GLEYSOL
13 COLLAPSED RUBBLE OF ESCARP
0 10 feet
0 3 m

172 **Dauphin Bastion**, section A-A, left flank escarp, and B-B. (Drawing by T.M. Smith.)

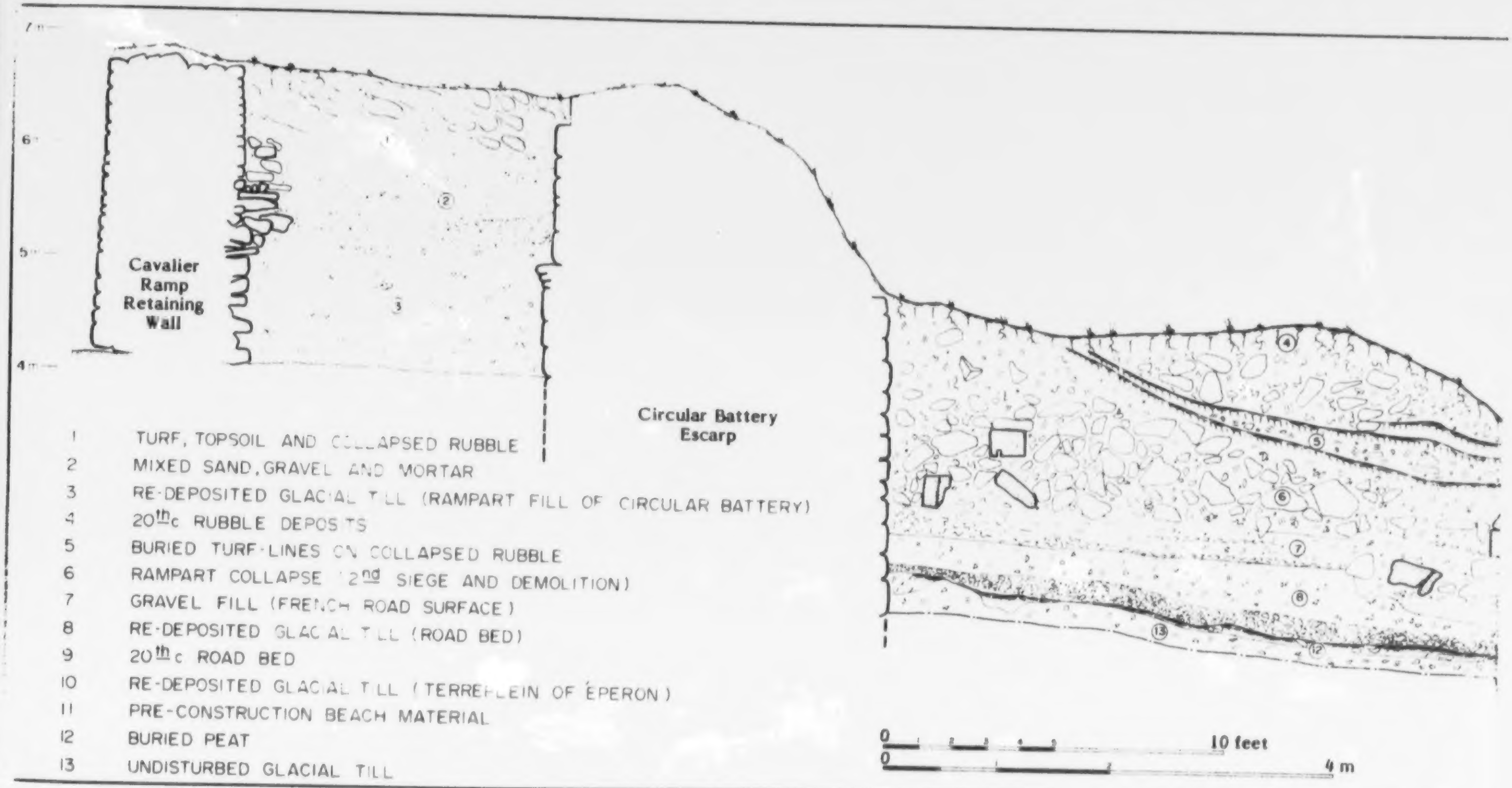

7m
6
5
4m
Cavalier Ramp Retaining Wall
2
3

1 TURF, TOPSOIL AND COLLAPSED F
2 MIXED SAND, GRAVEL AND MORT
3 RE-DEPOSITED GLACIAL TILL (RA
4 20th c. RUBBLE DEPOSITS
5 BURIED TURF-LINES ON COLLAPS
6 RAMPART COLLAPSE (2nd SIEGE
7 GRAVEL FILL (FRENCH ROAD SUF
8 RE-DEPOSITED GLACIAL TILL (ROA
9 20th c ROAD BED
10 RE-DEPOSITED GLACIAL TILL (TE
11 PRE-CONSTRUCTION BEACH MATE
12 BURIED PEAT
13 UNDISTURBED GLACIAL TILL

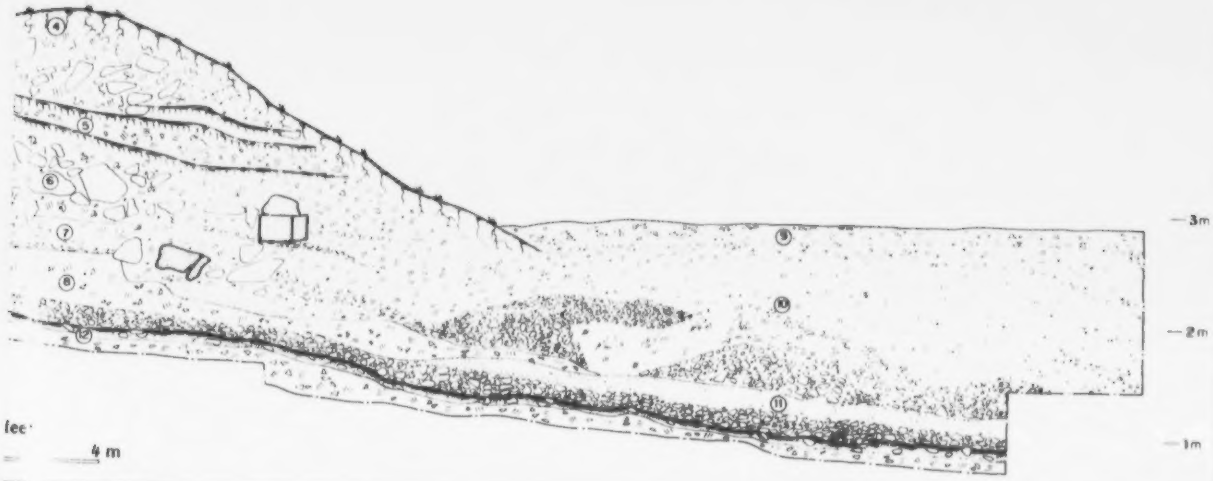
73 Dauphin Bastion, section C-C.
mith.)

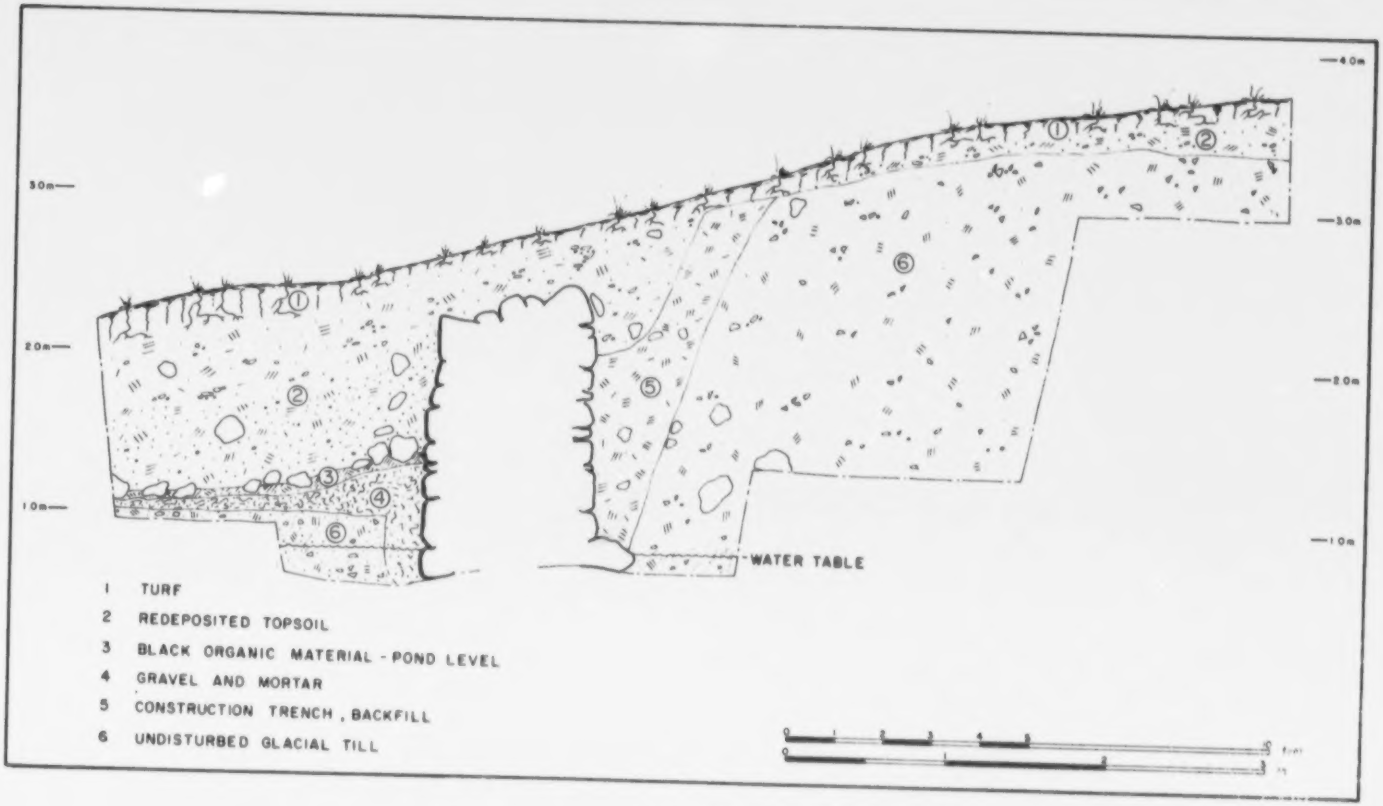

6m
5m
4m
3m
6
7
8
9
5
REAR REVETMENT OF CAVALIER

1 MODERN RUBBLE FILL
2 BURIED TURF LINE
3 REFUSE LAYER CONTAINING LATE 19th c MATERIAL
4 RAMPART FILL (RE-DEPOSITED GLACIAL TILL)
5 COLLAPSED RUBBLE
6 RE-DEPOSITED FILL
7 LIME MORTAR
8 18th c LAND SURFACE
9 UNDISTURBED GLAC


7 m
6
5
4 m
Cavalier Ramp Retaining Wall
Circular Battery Escarp
②
③
④
⑤
⑥
⑦
⑧
⑫
⑬
1 TURF, TOPSOIL AND COLLAPSED RUBBLE
2 MIXED SAND, GRAVEL AND MORTAR
3 RE-DEPOSITED GLACIAL TILL (RAMPART FILL OF CIRCULAR BATTERY)
4 20th c RUBBLE DEPOSITS
5 BURIED TURF-LINES ON COLLAPSED RUBBLE
6 RAMPART COLLAPSE (2nd SIEGE AND DEMOLITION)
7 GRAVEL FILL (FRENCH ROAD SURFACE)
8 RE-DEPOSITED GLACIAL TILL (ROAD BED)
9 20th c ROAD BED
10 RE-DEPOSITED GLACIAL TILL (TERREPLEIN OF ÉPERON)
11 PRE-CONSTRUCTION BEACH MATERIAL
12 BURIED PEAT
13 UNDISTURBED GLACIAL TILL
0
10 feet
0
4 m

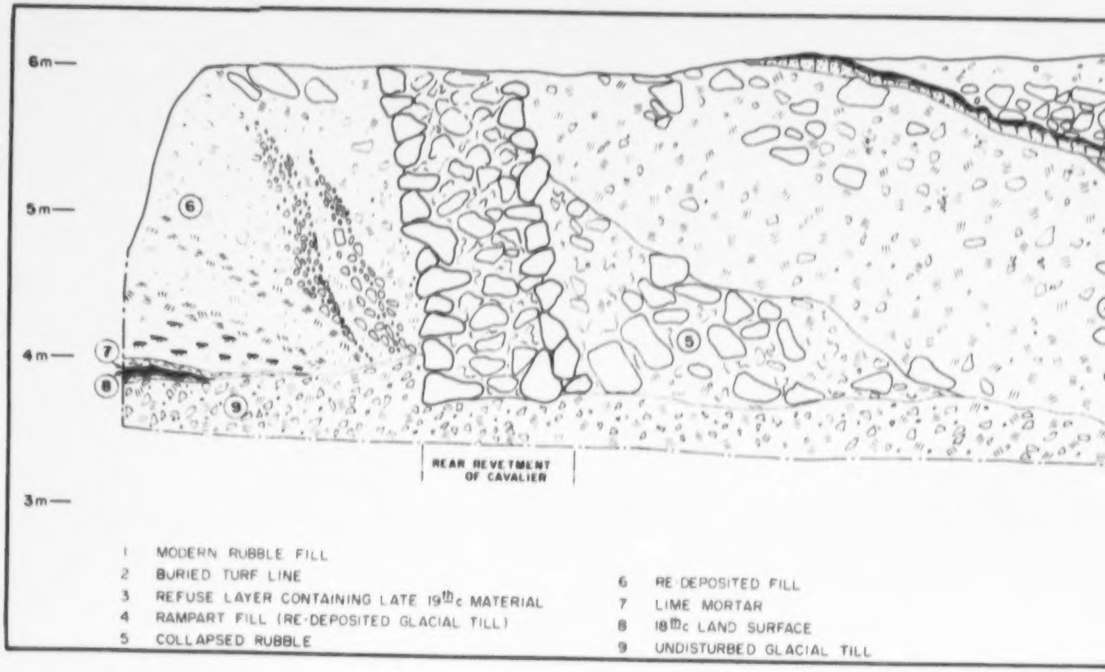
73 Dauphin Bastion, section C-C. (Drawing by T.M. mith.)

④
⑤
⑥
⑦
⑧
⑫
⑨
⑩
⑪
3m
2m
1m
fee
4 m

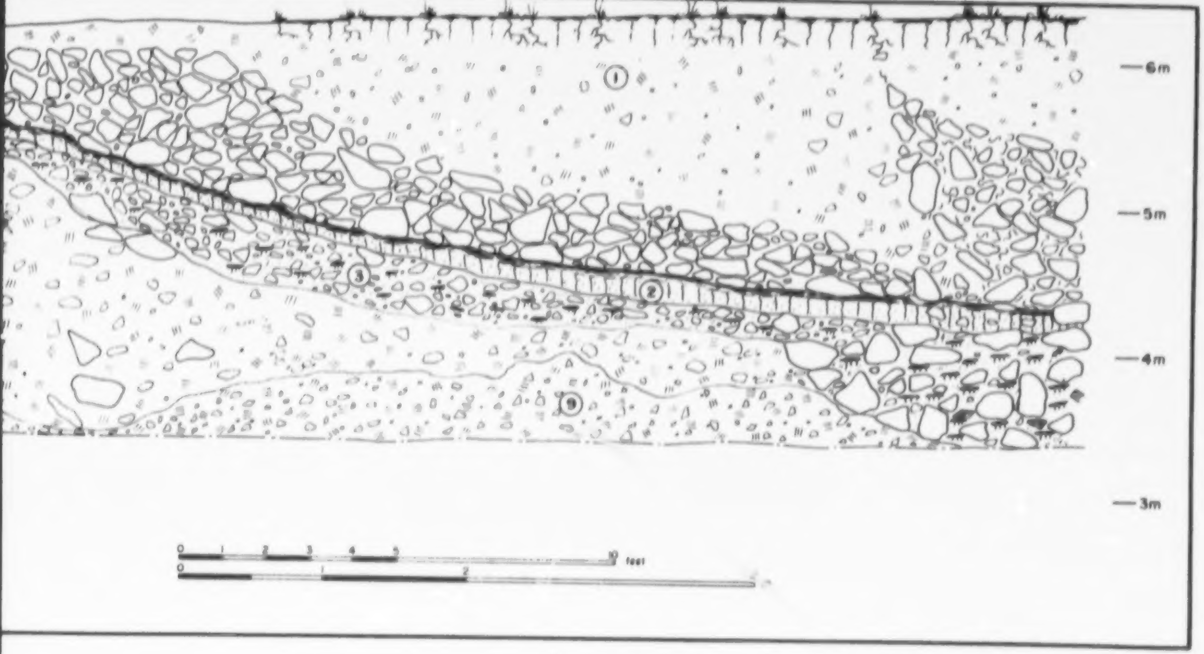


30m
20m
10m
40m
30m
20m
10m
①
②
③
④
⑤
⑥
WATER TABLE
1 TURF
2 REDEPOSITED TOPSOIL
3 BLACK ORGANIC MATERIAL - POND LEVEL
4 GRAVEL AND MORTAR
5 CONSTRUCTION TRENCH, BACKFILL
6 UNDISTURBED GLACIAL TILL
0
1
2
3
4
5
10
0
1
2
3

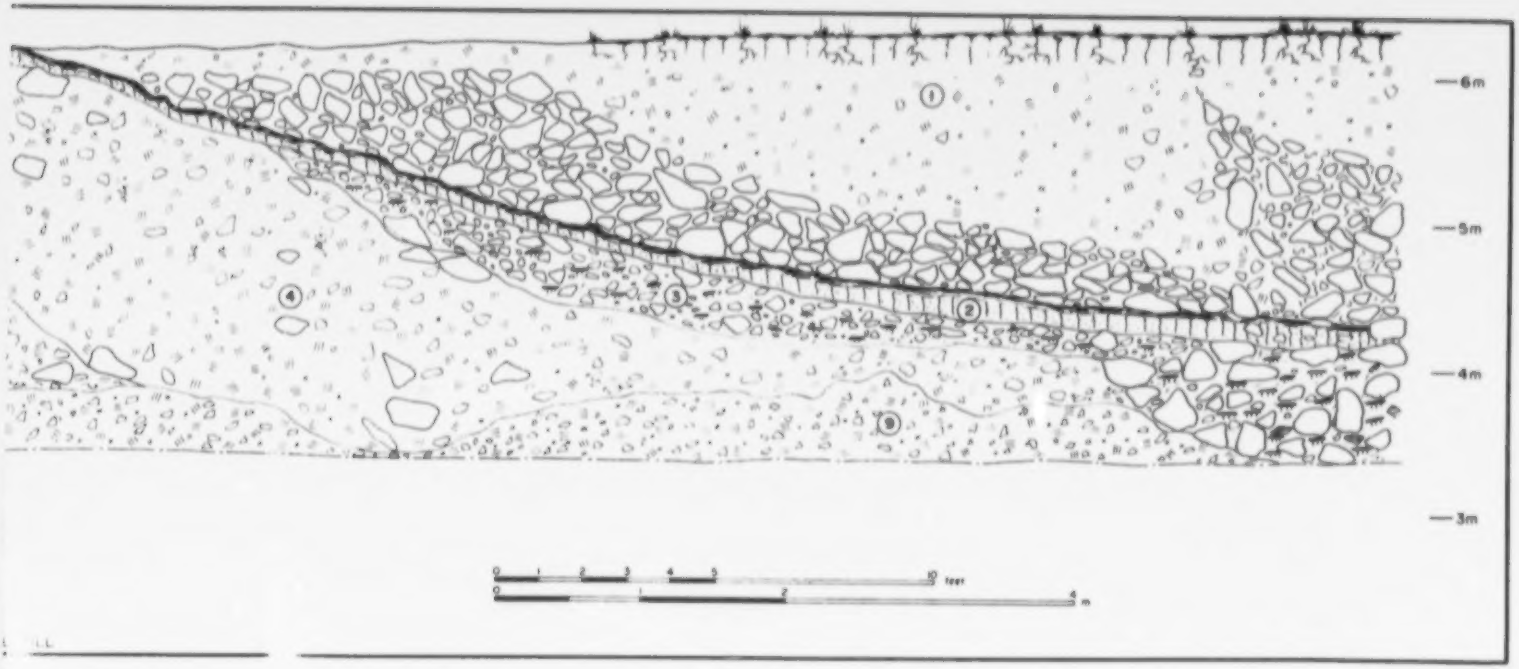
175 **Dauphin Bastion** outworks, section E-E. (Drawing by T.M. Smith.)


6m
5m
4m
3m
6
7
8
9
5
REAR REVETMENT OF CAVALIER

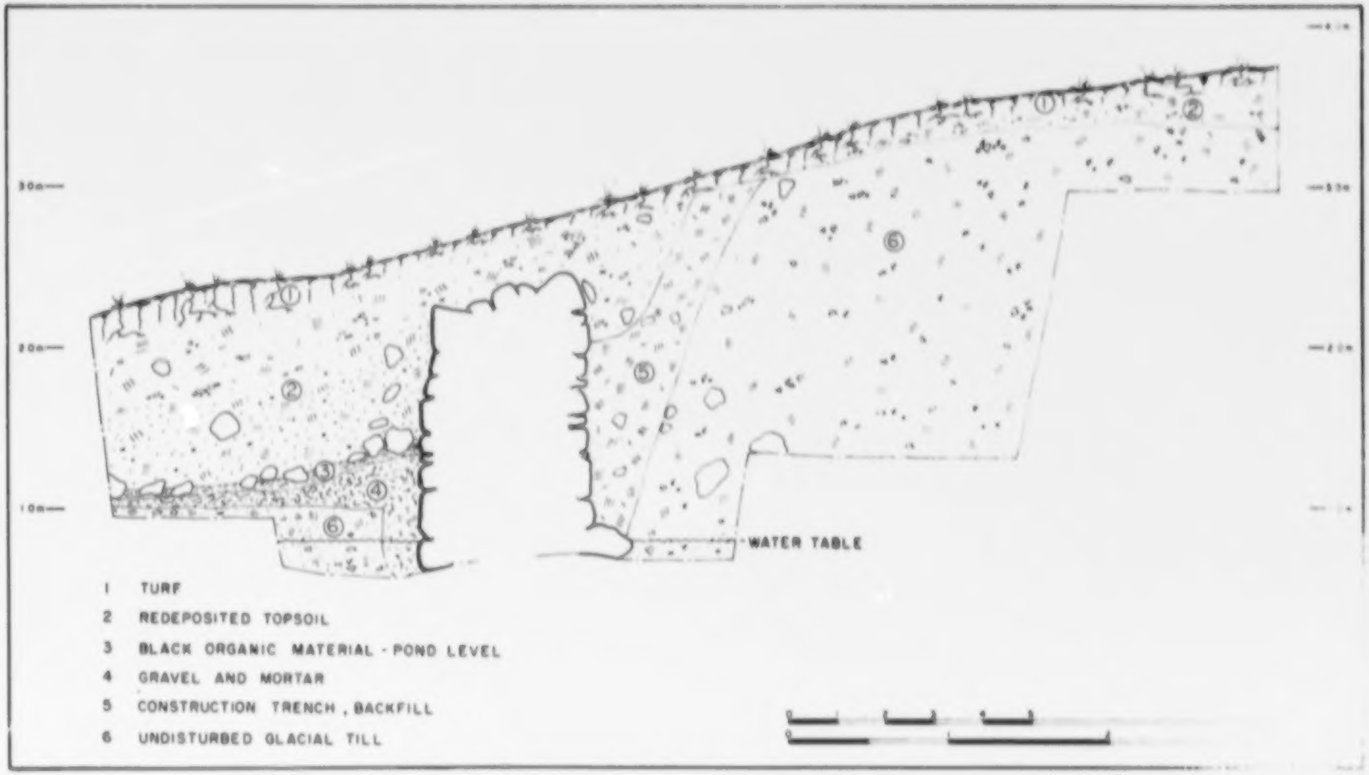
1 MODERN RUBBLE FILL
2 BURIED TURF LINE
3 REFUSE LAYER CONTAINING LATE 19th c MATERIAL
4 RAMPART FILL (RE-DEPOSITED GLACIAL TILL)
5 COLLAPSED RUBBLE
6 RE-DEPOSITED FILL
7 LIME MORTAR
8 18th c LAND SURFACE
9 UNDISTURBED GLACIAL TILL


①
②
③
⑨
6m
5m
4m
3m
0
1
2
3
4
5
10 feet
0
1
2

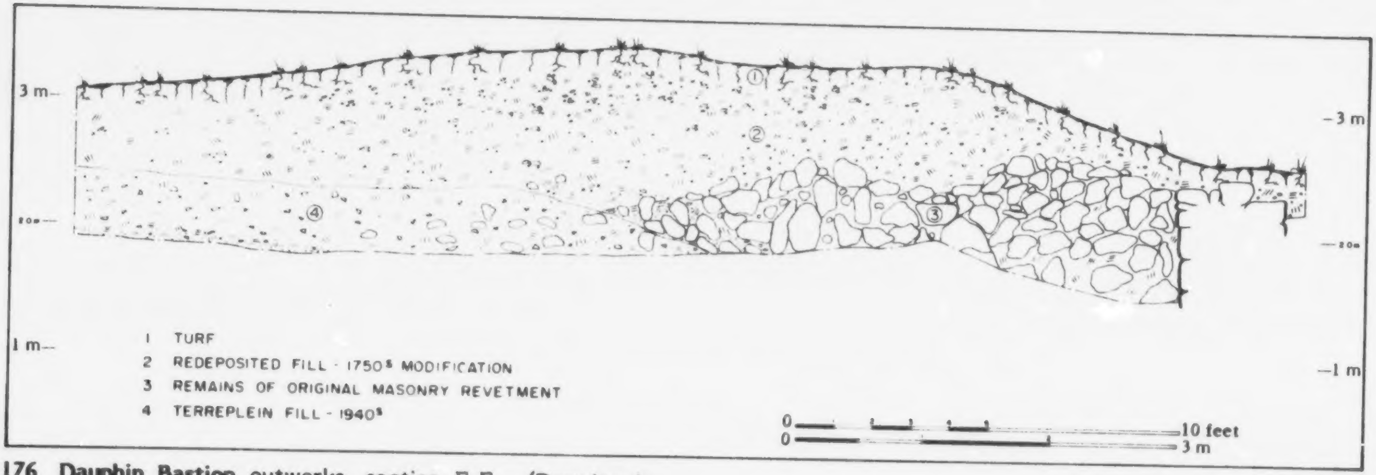
174 **Dauphin Bastion**, section D-D. (Drawing by T.M. Smith.)


①
②
③
④
— 6m
— 5m
— 4m
— 3m
0 1 2 3 4 5 10 feet
0 1 2 4 m

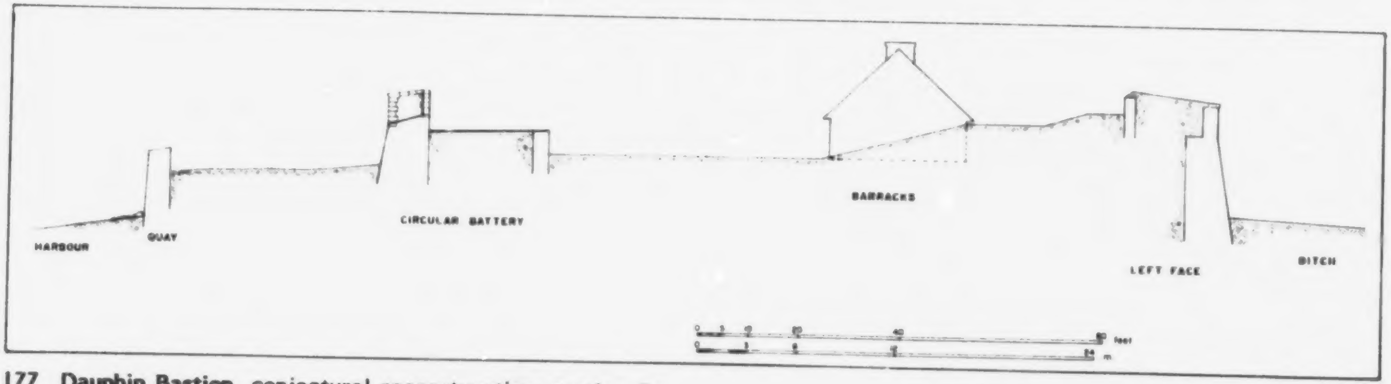
174 **Dauphin Bastion**, section D-D. (Drawing by T.M. Smith.)


30m
20m
10m
①
②
③
④
⑤
⑥
WATER TABLE
1 TURF
2 REDEPOSITED TOPSOIL
3 BLACK ORGANIC MATERIAL - POND LEVEL
4 GRAVEL AND MORTAR
5 CONSTRUCTION TRENCH, BACKFILL
6 UNDISTURBED GLACIAL TILL

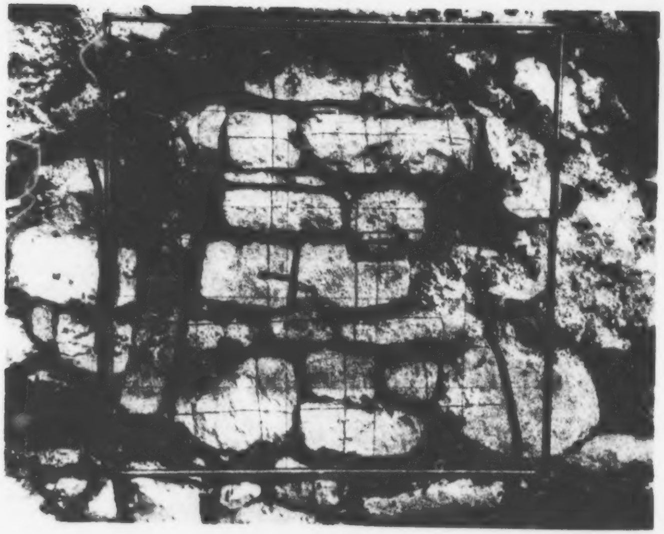
175 **Dauphin Bastion** outworks, section E-E. (Drawing by T.M. Smith.)


3 m
3 m
①
②
③
④
1 m
1 m
1 TURF
2 REDEPOSITED FILL - 1750s MODIFICATION
3 REMAINS OF ORIGINAL MASONRY REVETMENT
4 TERREPLEIN FILL - 1940s
0
10 feet
0
3 m

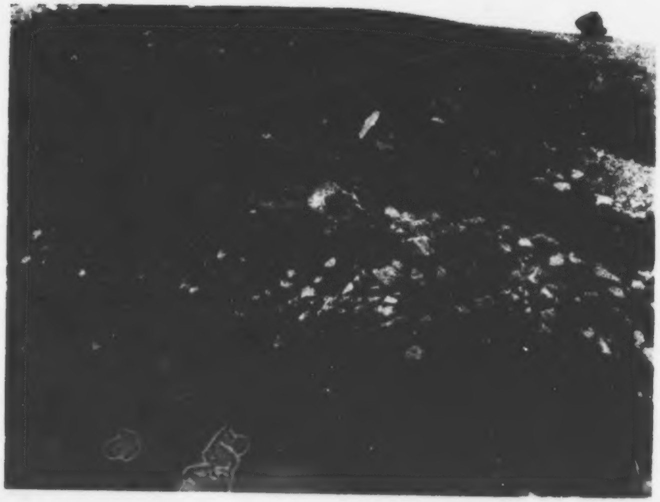
176 Dauphin Bastion outworks, section F-F. (Drawing by T.M. Smith.)


HARBOUR
QUAY
CIRCULAR BATTERY
BARRACKS
LEFT FACE
DITCH
0 5 10 20 40 80 feet
0 3 6 12 24 m

177 Dauphin Bastion, conjectural reconstruction, section G-G. (Drawing by T.M. Smith.)



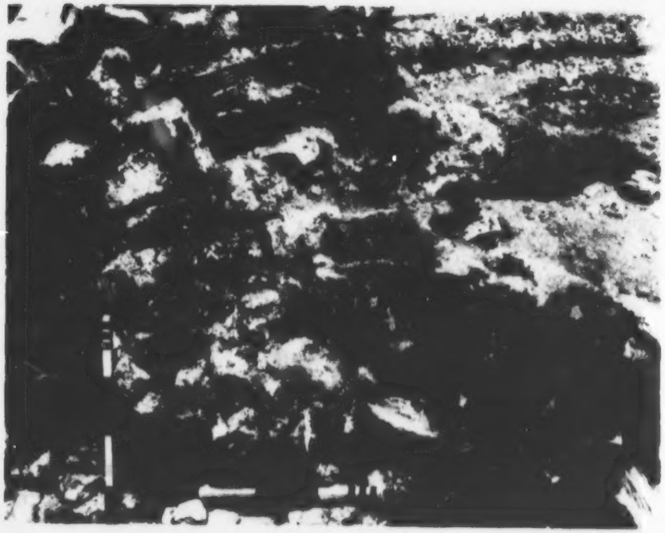
178 Dauphin Bastion. Left flank escarp; rebuilt outer facing of wall. Note use of dressed sandstone from earlier contexts. At centre right is part of sill from a gun embrasure. (Fortress of Louisbourg NHP.)



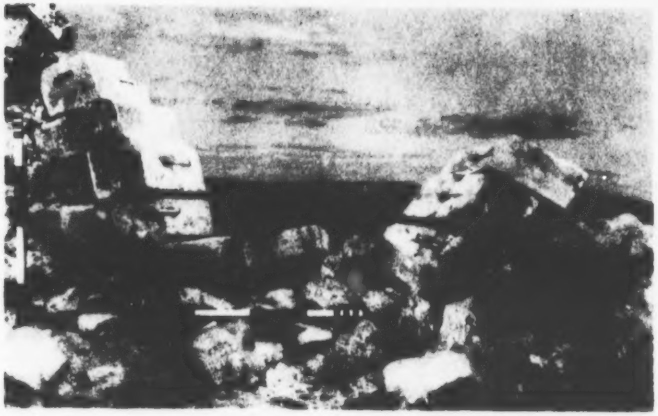
179 Dauphin Bastion. Left shoulder angle. Escarps of face (at left) and flank (at right) are little more than rubble. (Fortress of Louisbourg NHP.)

180 Dauphin Bastion. Circular Battery entrance: jamb of dressed sandstone with wrought-iron pintle *in situ*. End wall of ramp leading from quay to entrance is at upper left. (Fortress of Louisbourg NHP.)

181 Dauphin Bastion. Circular Battery entrance. Full width of entrance is indicated by wing walls, restricted entrance by location of jamb and pintle (adjacent to scale in foreground). (Fortress of Louisbourg NHP.)

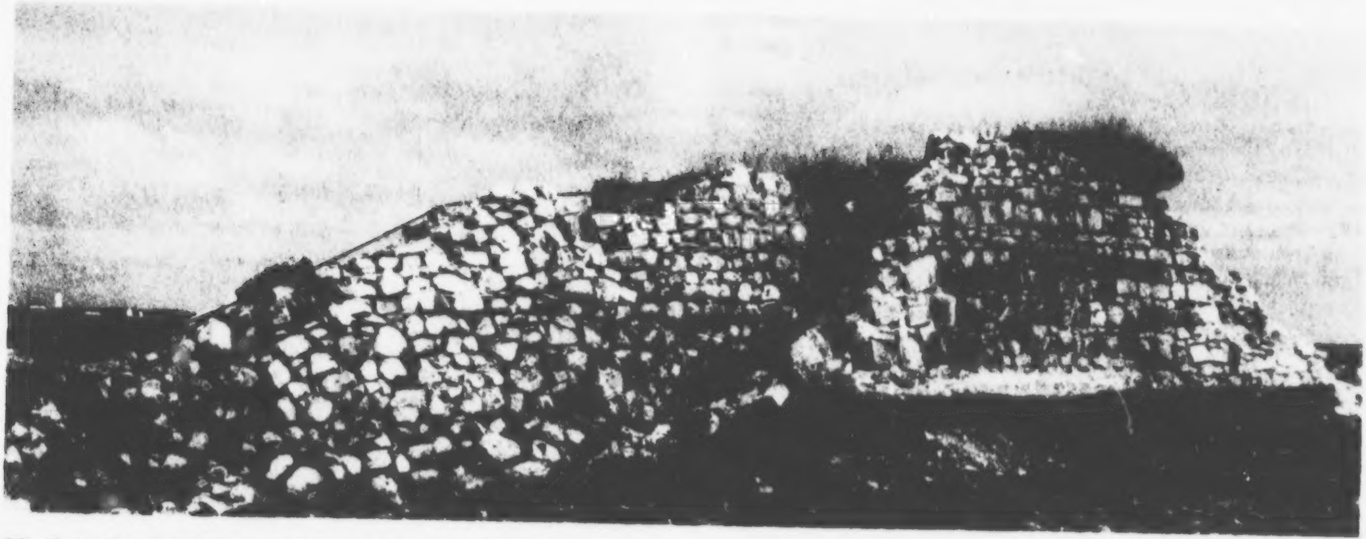


182 Dauphin Bastion. Circular Battery; *in situ* remains of interior revetment and blocked gun embrasure. (Fortress of Louisbourg NHP.)



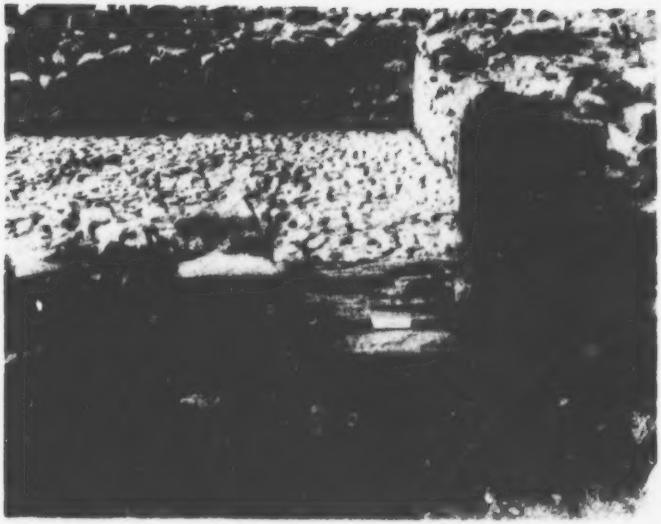
183 Dauphin Bastion. Circular Battery: *in situ* remains of gun embrasure, blocking removed. (Fortress of Louisbourg NHP.)

184 Dauphin Bastion. Tenaille front and cavalier. (Fortress of Louisbourg, NHP.)



185 Dauphin Bastion. Circular Battery and cavalier ramp retaining wall. Rear of escarp of battery at left, after removal of cavalier fill; retaining wall of ramp leading to cavalier at right. Note different masonry pattern. (Fortress of Louisbourg NHP.)

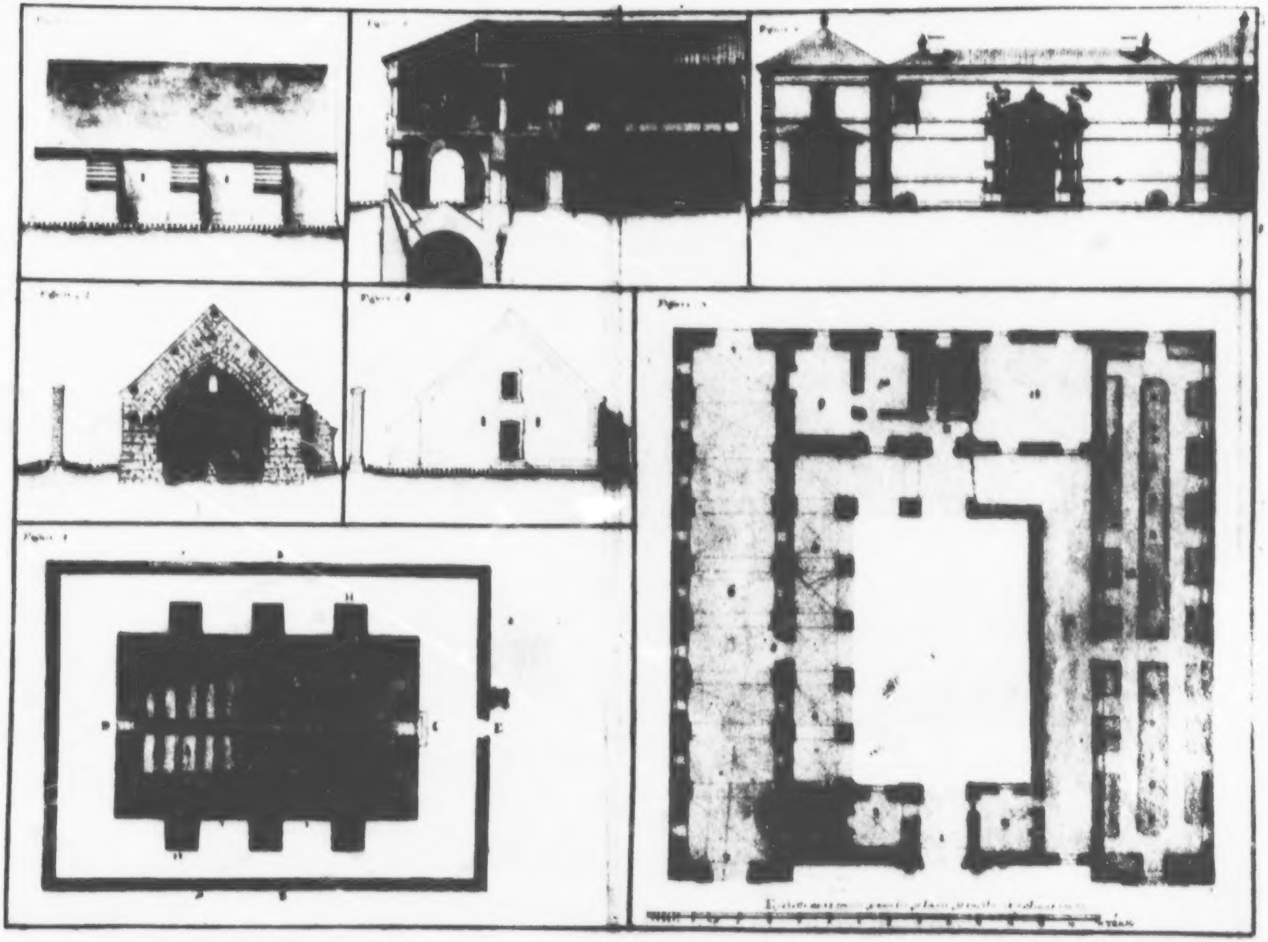
186 Dauphin Bastion. Barracks. Left face rampart is at rear. (Fortress of Louisbourg NHP.)



187 Dauphin Bastion. Barracks: dressed sandstone surround of modified entrance. Note brick threshold. (Fortress of Louisbourg NHP.)

188 Dauphin Bastion. Powder magazine after excavation. Note masonry keyed to roof at rampart level, upper right; also parallel troughs in masonry to receive roof timbers on side wall, left. (Fortress of Louisbourg NHP.)

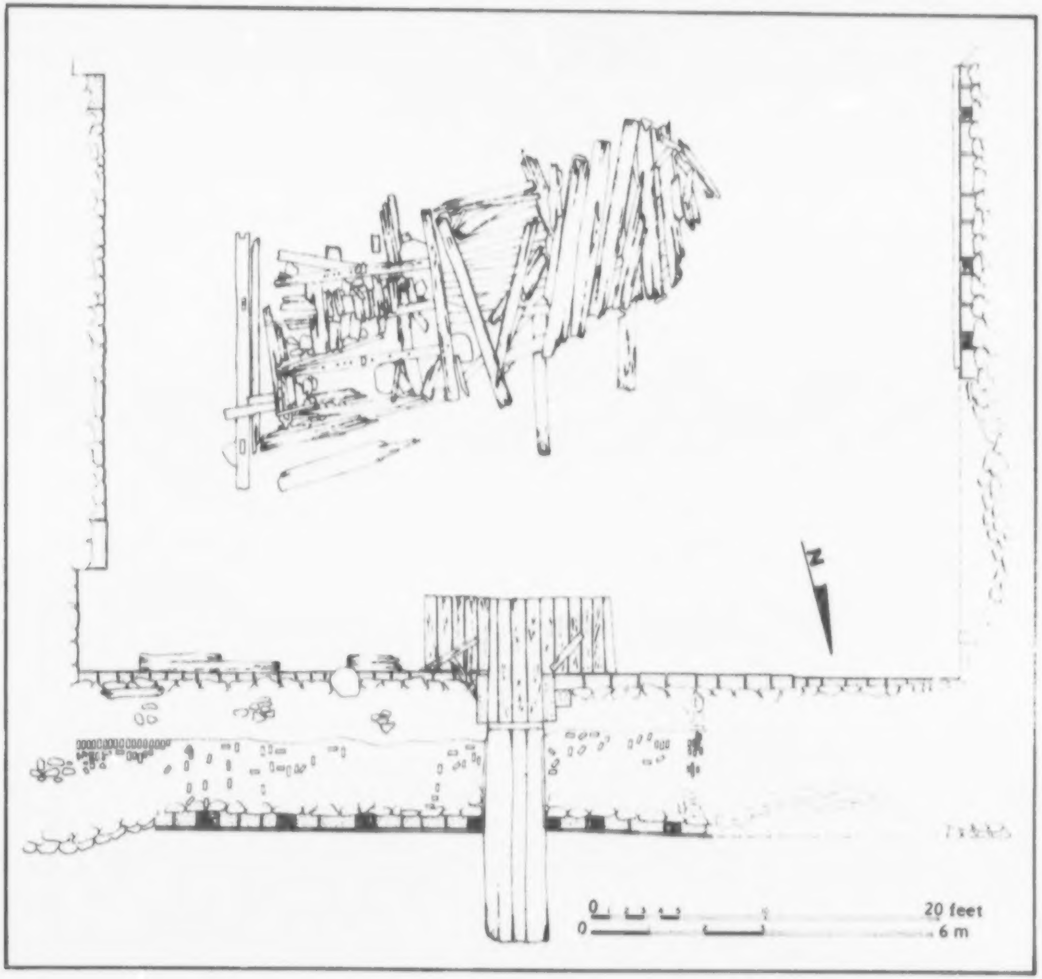
189 Dauphin Bastion. Powder magazine: spring of the arch with remains of brick lining. (Fortress of Louisbourg NHP.)



190 Dauphin Bastion. Powder magazine and arsenal. Claude Masse. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)

191 Dauphin Gate. Remains of drawbridge; fixed portion of bridge with plank decking in background. (Fortress of Louisbourg NHP.)

192 Dauphin Bastion. Tenaille front and gate; recording grid in place over remains of drawbridge. Note sandstone block marking angle of barbette. Below plastic shelter, rubble-filled foundations of soldiers' guardhouse; note remains of brick arch spanning the later entrance through rampart. (Fortress of Louisbourg NHP.)


N
0
20 feet
0
6 m

193 Dauphin Bastion. *Batardeau*, sluice and drawbridge remains. (Drawing by T.M. Smith.)

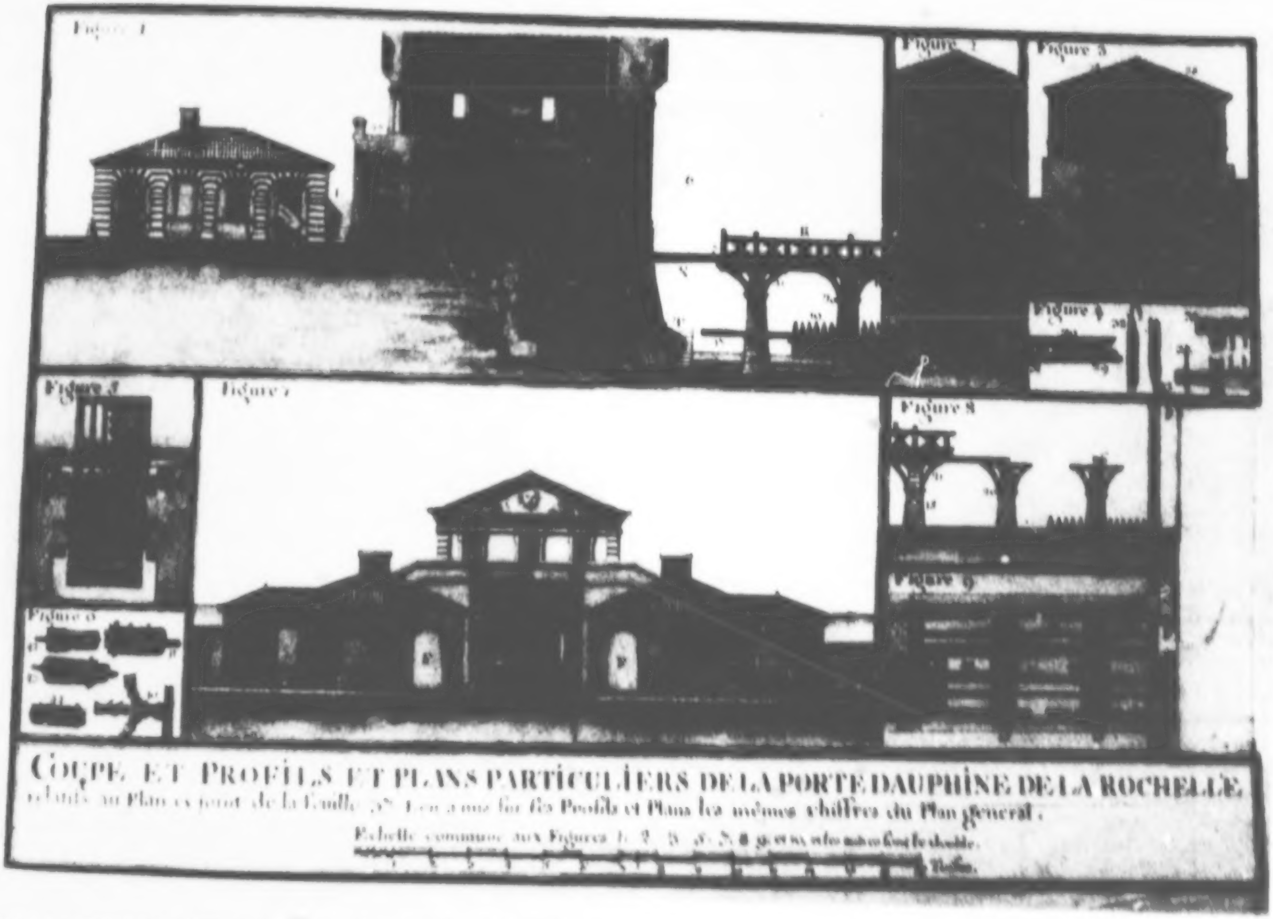
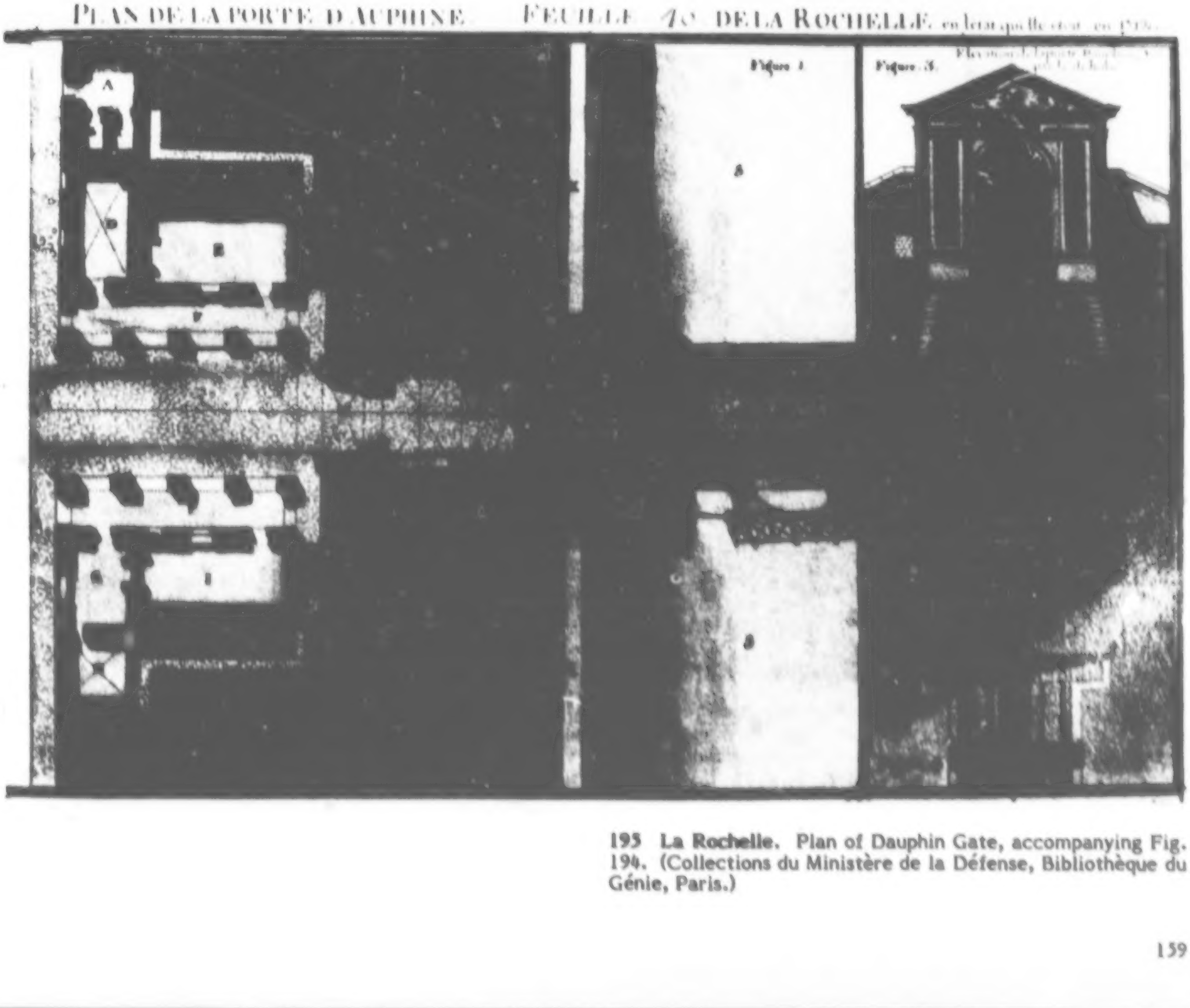


Figure 1
Figure 2
Figure 3
Figure 4
Figure 5
Figure 6
Figure 7
Figure 8
Figure 9
COUPE ET PROFILS ET PLANS PARTICULIERS DE LA PORTE DAUPHINE DE LA ROCHELLE
relatifs au Plan ... on a mis sur ses Profils et Plans les mêmes chiffres du Plan général.
Echelle commune aux Figures 1. 2. 3. 4. 5. 8
Toises.

194 La Rochelle (Charente-Maritime). Dauphin Gate and guardhouses. Location of guardhouses is comparable to Louisbourg examples, but there is an upper guardroom with *orgues* (inset, upper right). Drawbridge does not have overhead swipe-beams, but pivots at the base of gateway so that counterweight swings down into chamber at ditch level (cf. Queen's Gate, Louisbourg). (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)

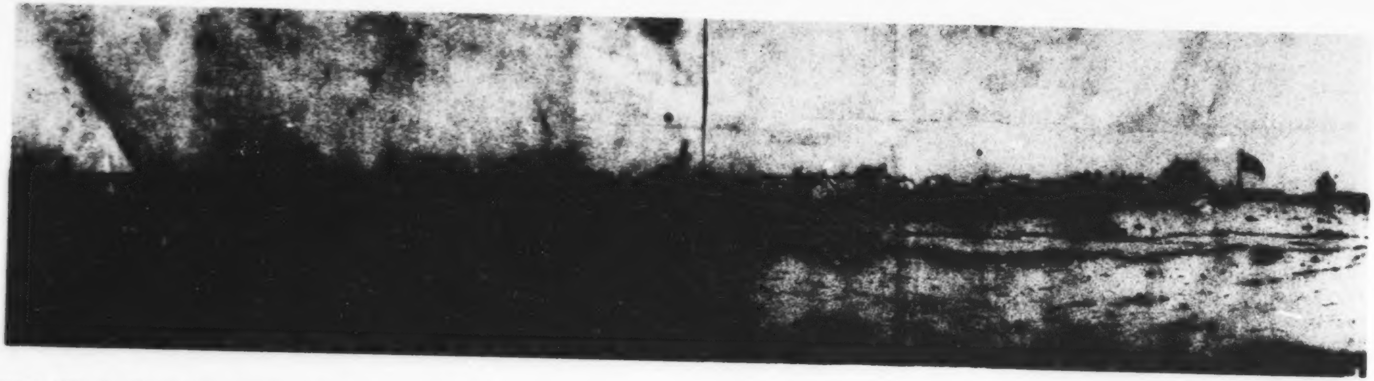

PLAN DE LA PORTE DAUPHINE
FEUILLE 40 DE LA ROCHELLE
Figure 1
Figure 3
A

195 La Rochelle. Plan of Dauphin Gate, accompanying Fig. 194. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)

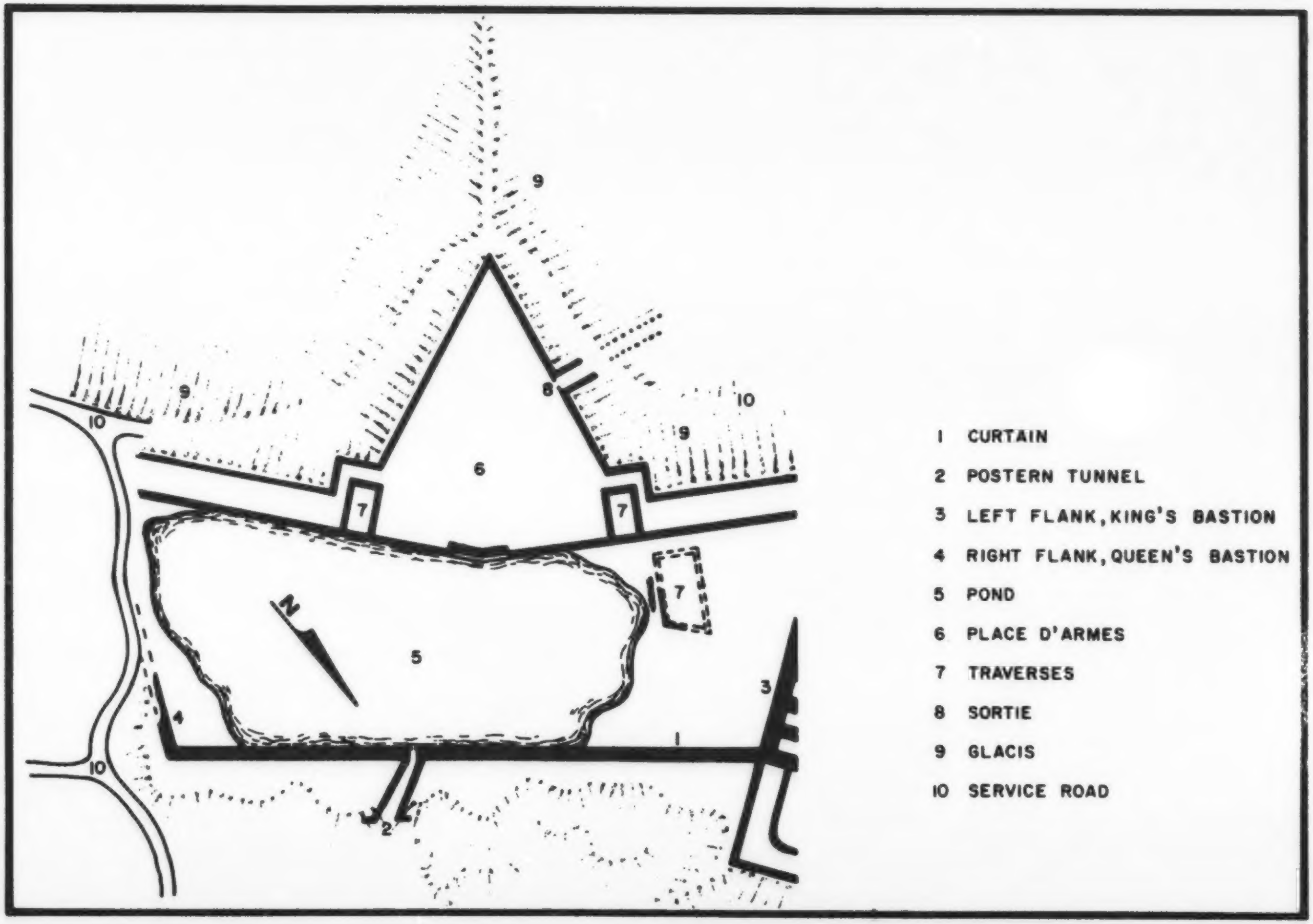
196 King's Bastion. Postern tunnel: view from above of postern roof. Terminating wall of right flank is at left (beneath plywood shelter); remains of King's-Dauphin curtain escarp is upper centre. Counterscarp of ditch in front of citadel barracks (foreground) forms one wall of postern; dressed sandstone vent surround is at lower left. On top of roof, butting onto terminating wall of flank, is interior revetment of curtain parapet. (Fortress of Louisbourg NHP.)

197 Outworks. Sandstone quoins terminating original counterscarp in front of Dauphin Bastion at right, plank revetment of Franquet's tenaille at left. (Fortress of Louisbourg NHP.)

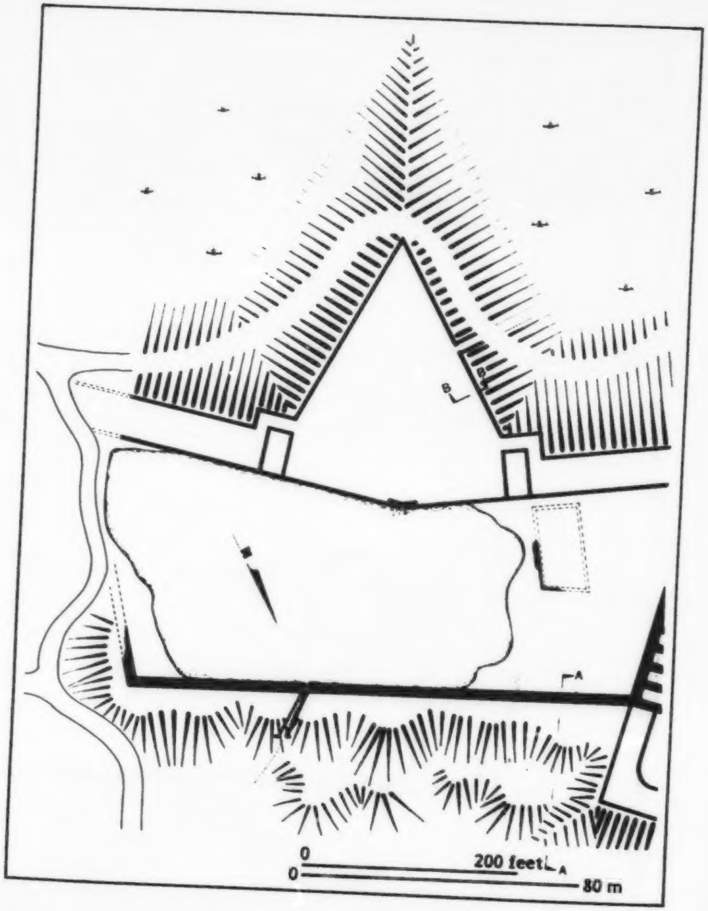
198 King's Bastion. Postern tunnel: doorway overlooking the ditch, reassembled from stones recovered during excavation. (Fortress of Louisbourg NHP.)



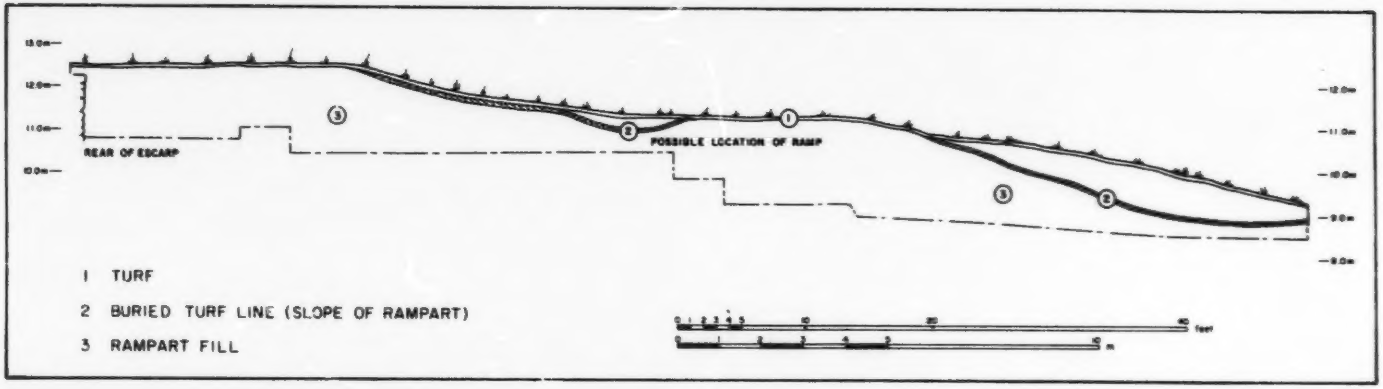
199 King's-Dauphin front after demolition, Thomas Wright, 1766. British blockhouse is at extreme right. (British Library.)


9
9
10
8
10
9
6
7
7
7
5
N
3
4
1
10
2
1 CURTAIN
2 POSTERN TUNNEL
3 LEFT FLANK, KING'S BASTION
4 RIGHT FLANK, QUEEN'S BASTION
5 POND
6 PLACE D'ARMES
7 TRAVERSES
8 SORTIE
9 GLACIS
10 SERVICE ROAD

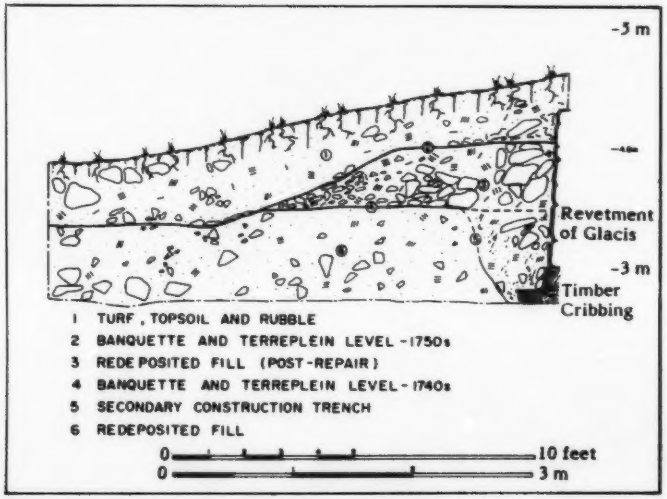
200 King's-Queen's curtain and *place d'armes*: key to principal features. (Drawing by T.M. Smith.)


B
A
A
0
200 feet
0
80 m

201 King's-Queen's curtain and *place d'armes:* key to sections. (Drawing by T.M. Smith.)


13.0m
12.0m
11.0m
10.0m
REAR OF ESCARP
POSSIBLE LOCATION OF RAMP
12.0m
11.0m
10.0m
9.0m
8.0m
1 TURF
2 BURIED TURF LINE (SLOPE OF RAMPART)
3 RAMPART FILL
0 1 2 3 4 5 10 20 40 feet
0 1 2 3 4 5 10 m

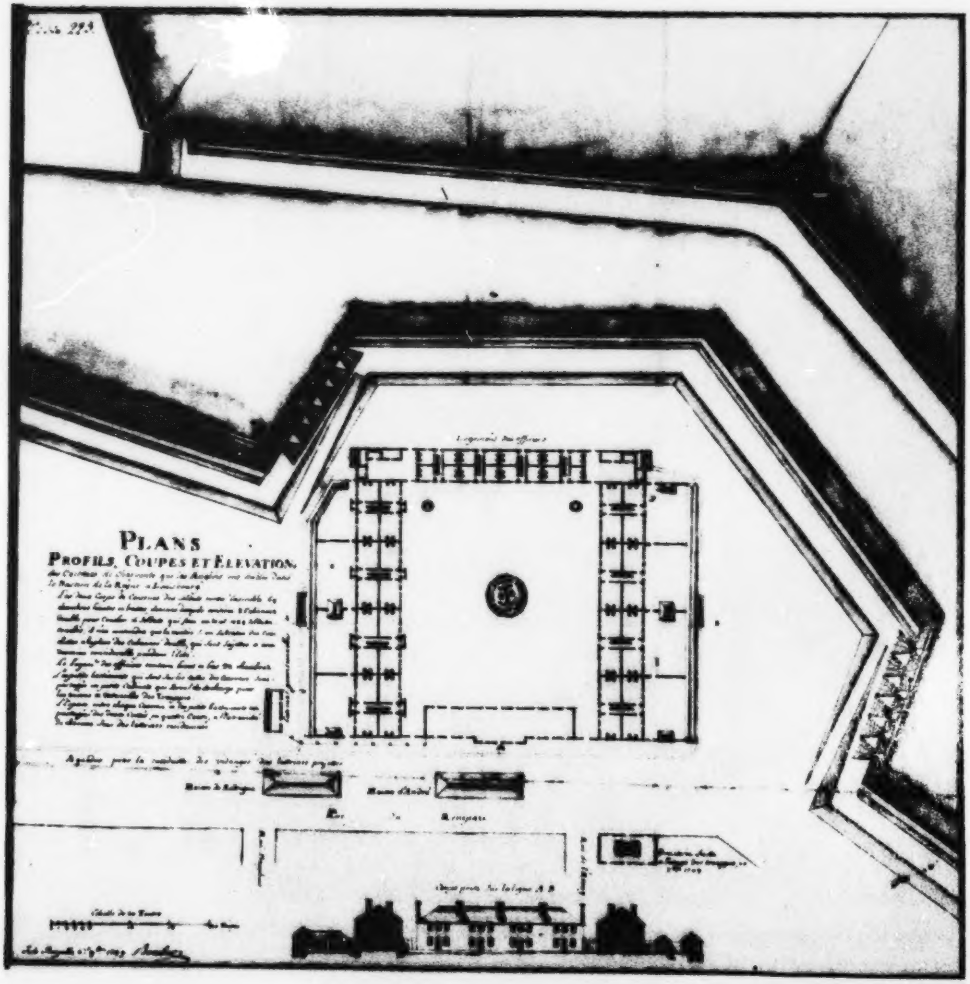
202 King's-Queen curtain, section A-A. (Drawing by T.M. Smith.)


-5 m
-4m
Revetment of Glacis
-3 m
Timber Cribbing
1 TURF, TOPSOIL AND RUBBLE
2 BANQUETTE AND TERREPLEIN LEVEL - 1750s
3 REDEPOSITED FILL (POST-REPAIR)
4 BANQUETTE AND TERREPLEIN LEVEL - 1740s
5 SECONDARY CONSTRUCTION TRENCH
6 REDEPOSITED FILL
0 10 feet
0 3 m

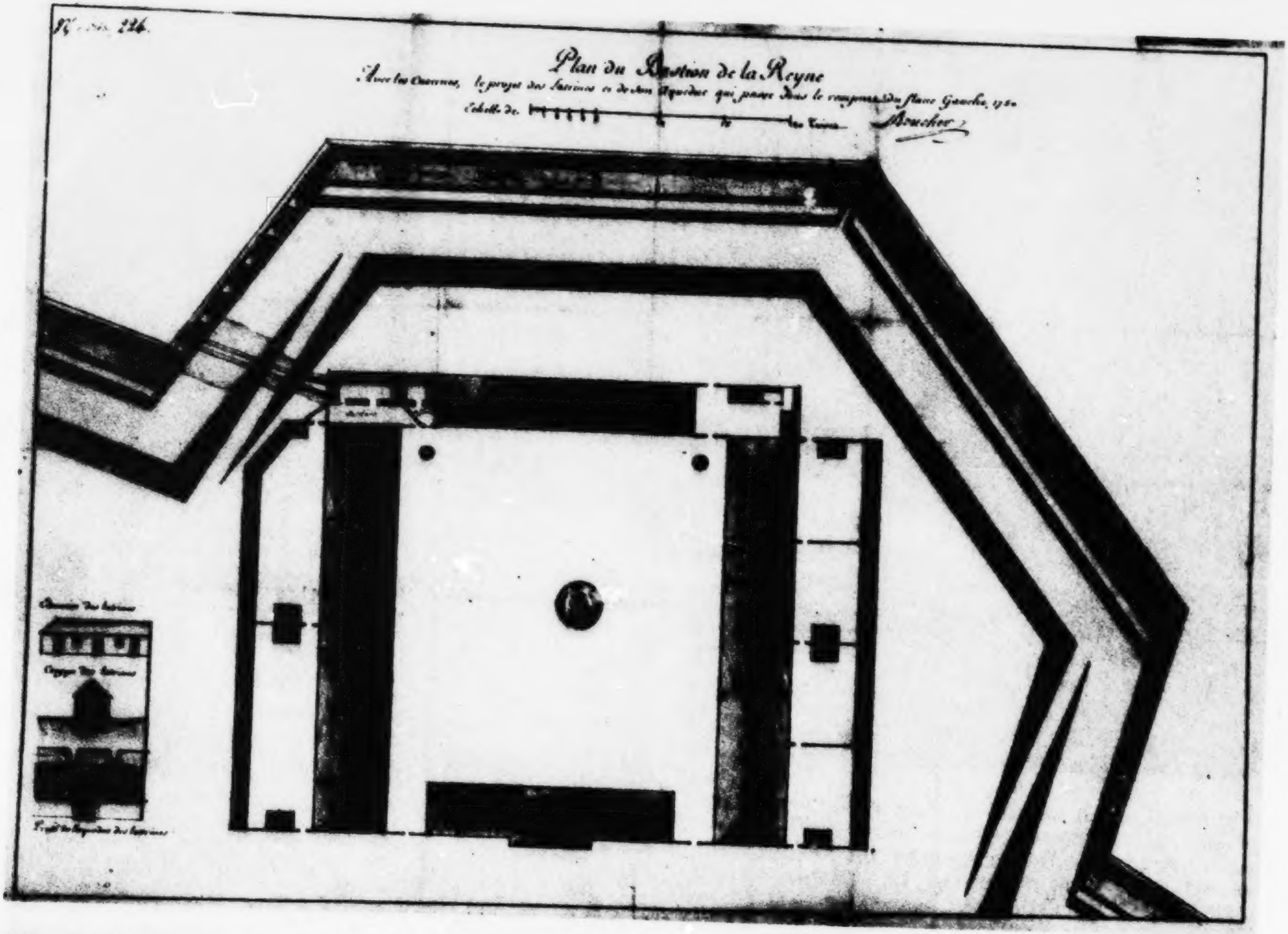
203 King's-Queen's *place d'armes*, section B-B. (Drawing by T.M. Smith.)

204 Outworks. Counterscarp with dressed sandstone steps leading to *place d'armes* in front of King's-Queen's curtain; remains of wooden bridge from postern in curtain. (Fortress of Louisbourg NHP.)

205 King's-Queen's curtain. Postern tunnel viewed from the town. Flanking walls, retaining rampart fill on each side of entrance, are in foreground; doorway and start of tunnel is set back in slope of rampart. Note stony fill beneath threshold, also drainage channel below fill. (Fortress of Louisbourg NHP.)

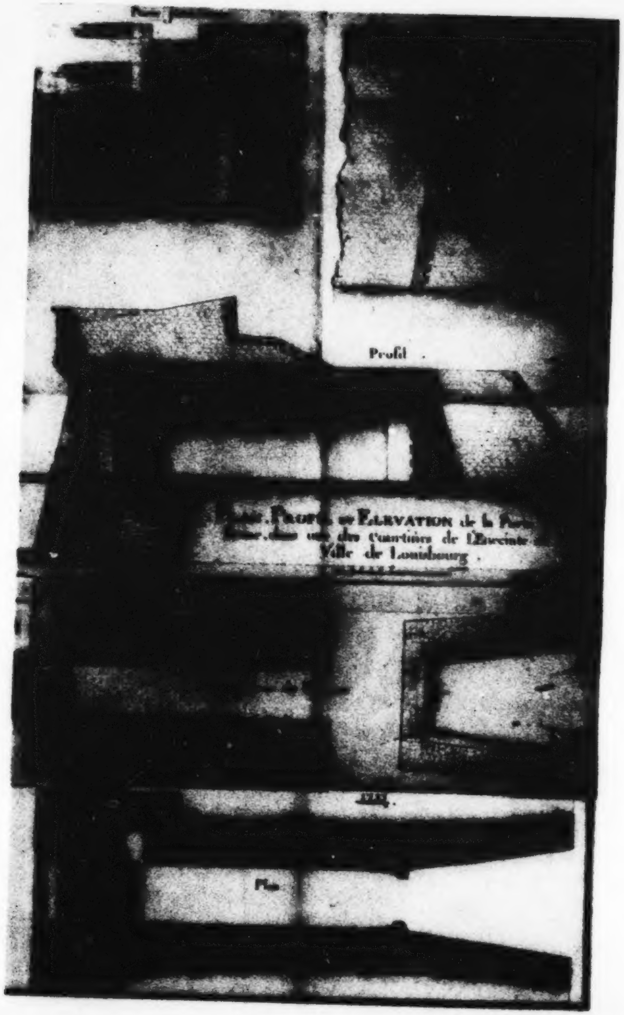

PLANS
PROFILS, COUPES ET ELEVATION

206 Queen's Bastion. New England barracks, Boucher, 1749. (Archives Nationales, Paris.)

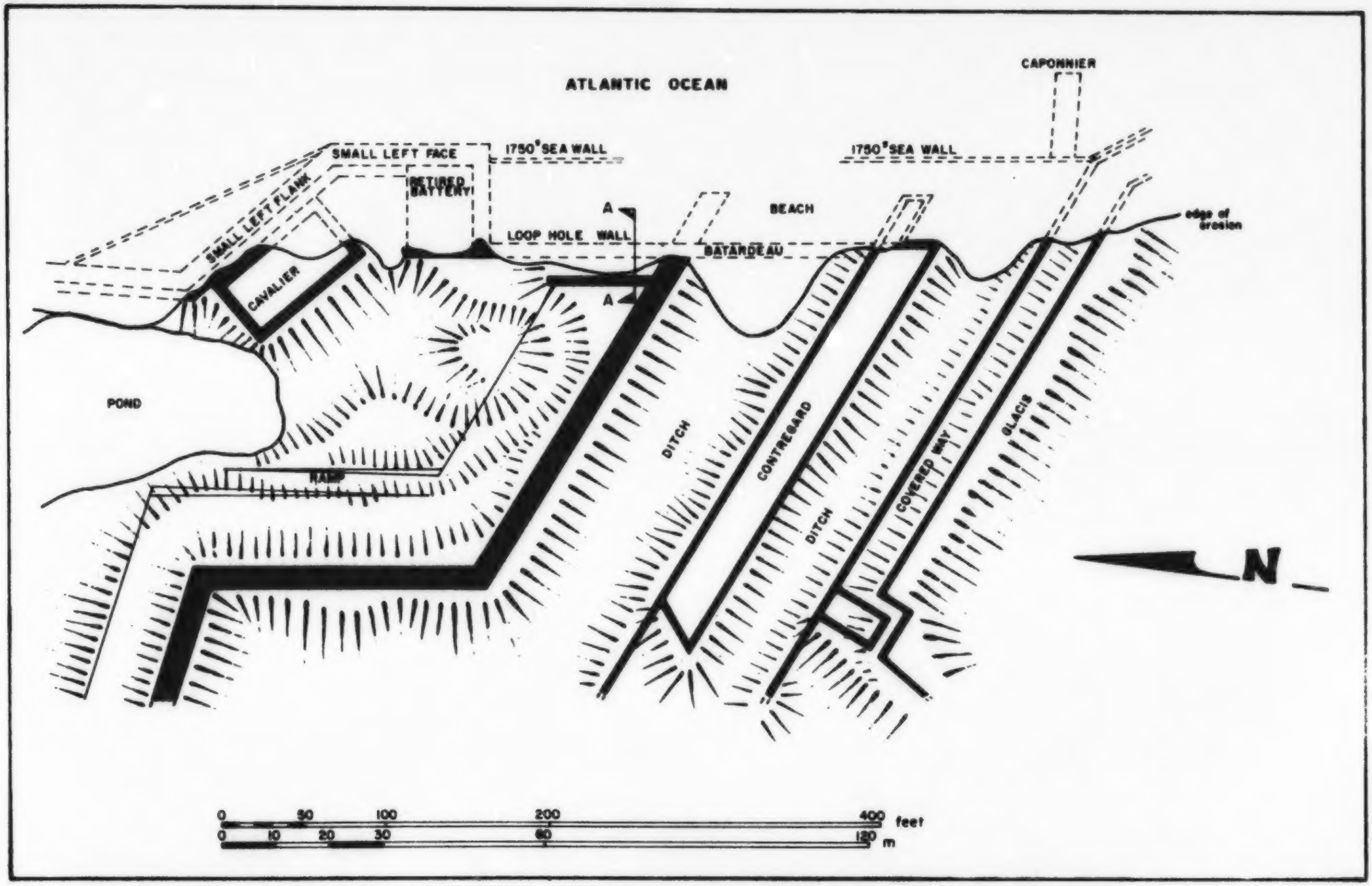

Plan du Bastion de la Reyne
Avec les Casernes, le projet des latrines et de son Aqueduc qui passe dans le ... du flanc Gauche, 1750
Echelle de ... Toises
Boucher

207 **Queen's Bastion**, Boucher, 1750. The barracks built by the New England forces during the 1745-49 occupation are shown; also Boucher's latrine, emptying into the ditch. (Archives Nationales, Paris.)

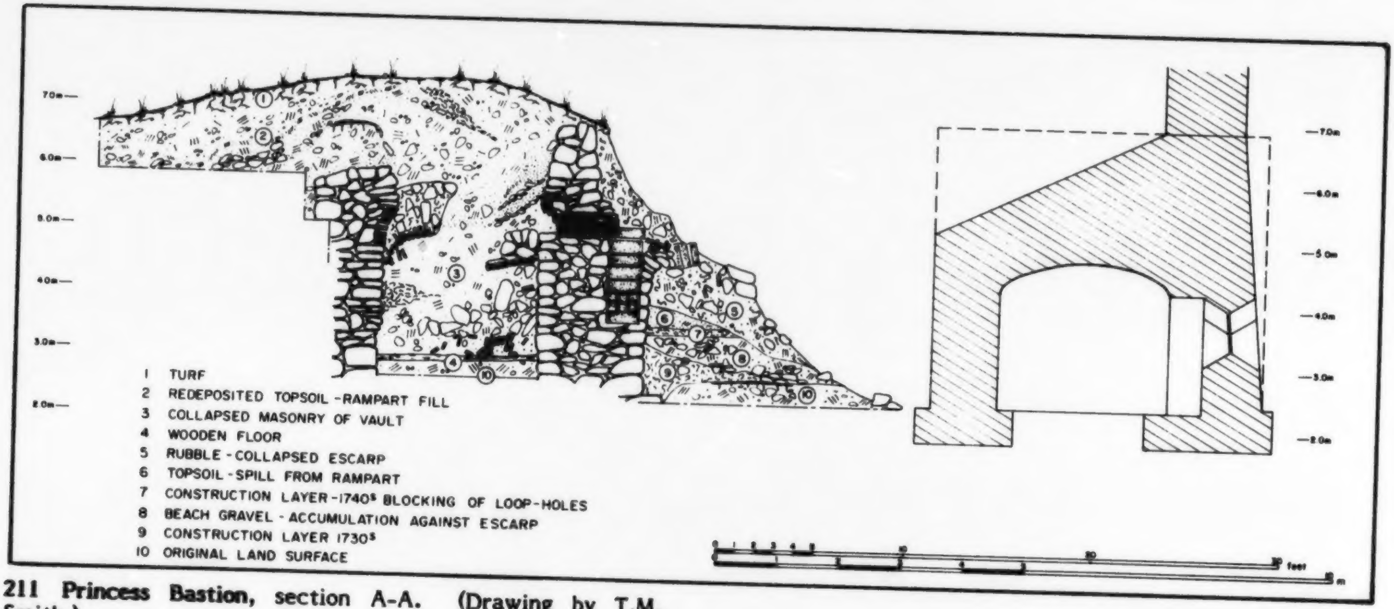
208 Landward defences. Low-level aerial view, Queen's Bastion in centre. Outline of New England Barracks is clearly visible. Note outline of *place d'armes* and traverses, lower left, covered but not obscured by Franquet's *demi-lune*, in front of Queen's-Princess curtain. Note also absence of curtain ramparts in area of pond in front of Dauphin Bastion (extreme top of picture). (Fortress of Louisbourg NHP.)


Profil .
Profil et Elevation de la
une des Courtines de l'Enceinte
Ville de Louisbourg .
1733.
Plan

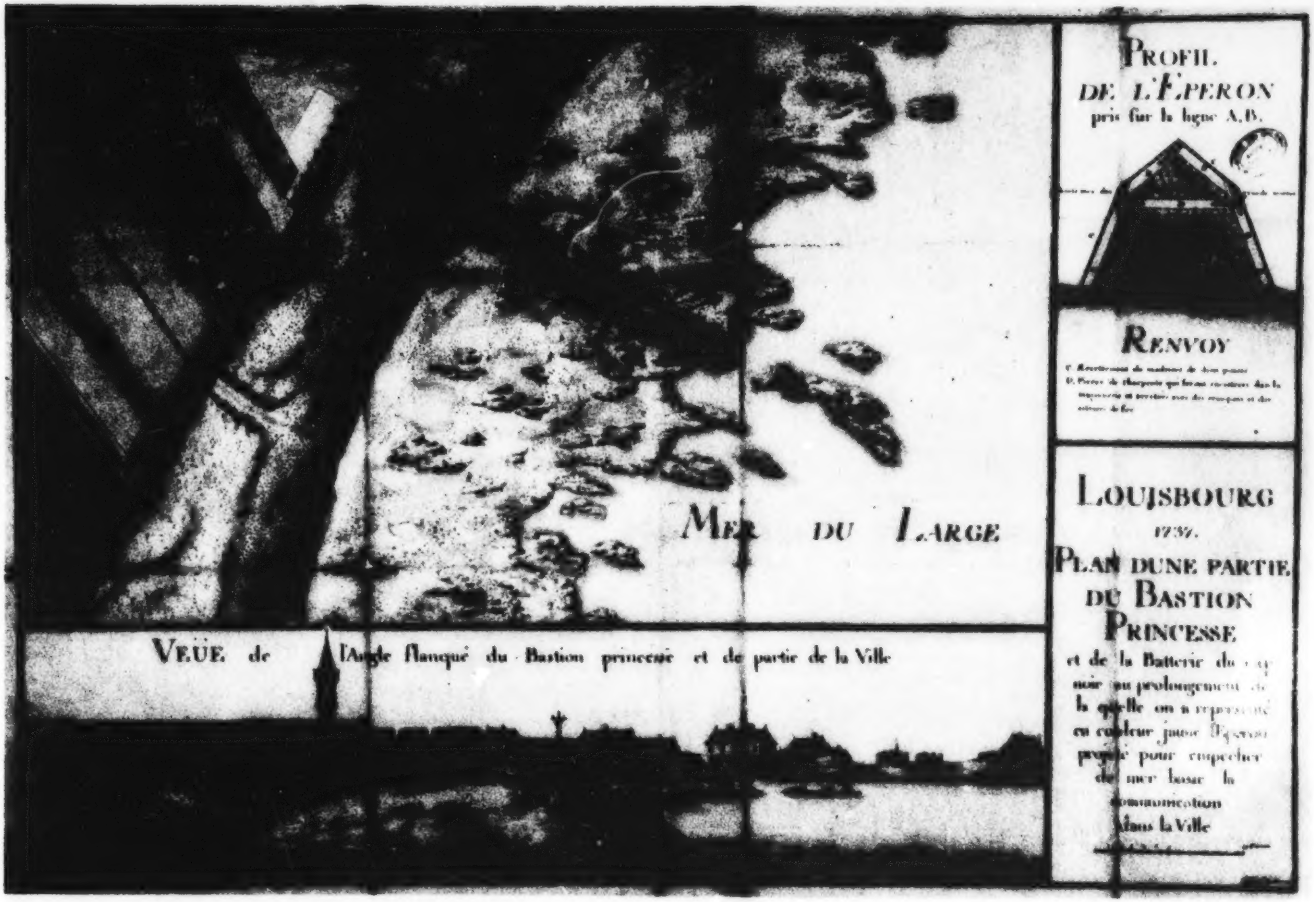
209 Queen's Gate, 1733 proposals. The bascule chamber, shown on centre profile, is reached by a flight of steps from the upper door in the passageway, as depicted if the "plan Superior" section is folded back (lower drawing). (Archives Nationales, Paris.)


ATLANTIC OCEAN
CAPONNIER
SMALL LEFT FACE
1750'SEA WALL
1750'SEA WALL
RETIRED BATTERY
SMALL LEFT FLANK
A
BEACH
LOOP HOLE WALL
BATARDEAU
edge of erosion
CAVALIER
A
POND
RAMP
DITCH
CONTREGARD
DITCH
COVERED WAY
GLACIS
N
0
50
100
200
400
feet
0
10
20
30
60
120
m

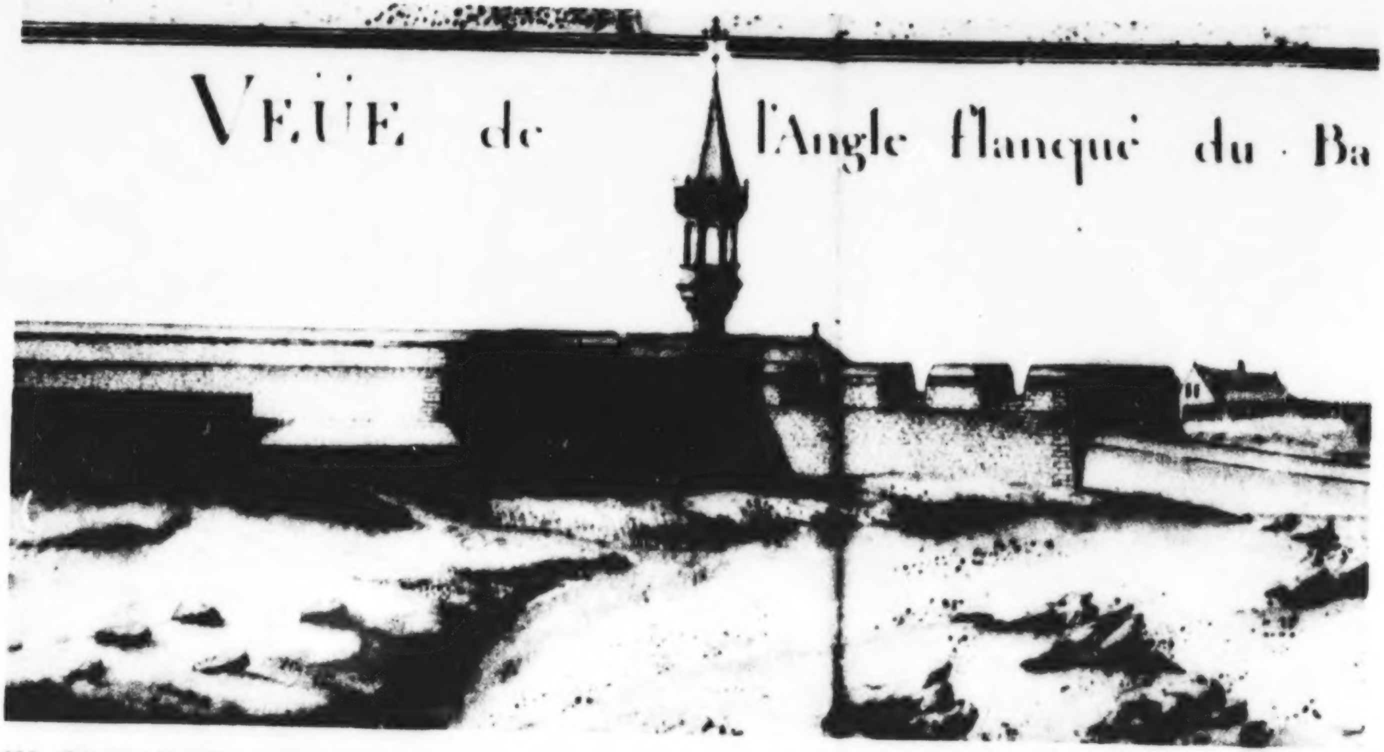
210 Princess Bastion. The outline of fortifications from the 1758 plan has been superimposed on existing contours and exposed structures. (Drawing by T.M. Smith.)


7.0m
6.0m
5.0m
4.0m
3.0m
2.0m
1 TURF
2 REDEPOSITED TOPSOIL - RAMPART FILL
3 COLLAPSED MASONRY OF VAULT
4 WOODEN FLOOR
5 RUBBLE - COLLAPSED ESCARP
6 TOPSOIL - SPILL FROM RAMPART
7 CONSTRUCTION LAYER - 1740s BLOCKING OF LOOP-HOLES
8 BEACH GRAVEL - ACCUMULATION AGAINST ESCARP
9 CONSTRUCTION LAYER 1730s
10 ORIGINAL LAND SURFACE
feet
m

211 **Princess Bastion**, section A-A. (Drawing by T.M. Smith.)


PROFIL
DE L'EPERON
pris sur la ligne A.B.
RENVOY
LOUISBOURG
1737.
PLAN DUNE PARTIE
DU BASTION
PRINCESSE
et de la Batterie du cap
noir au prolongement de
laquelle on a representé
en couleur jaune l'Eperon
projeté pour empecher
de mer basse la
communication
dans la Ville
MER DU LARGE
VEUE de l'Angle flanqué du Bastion princesse et de partie de la Ville

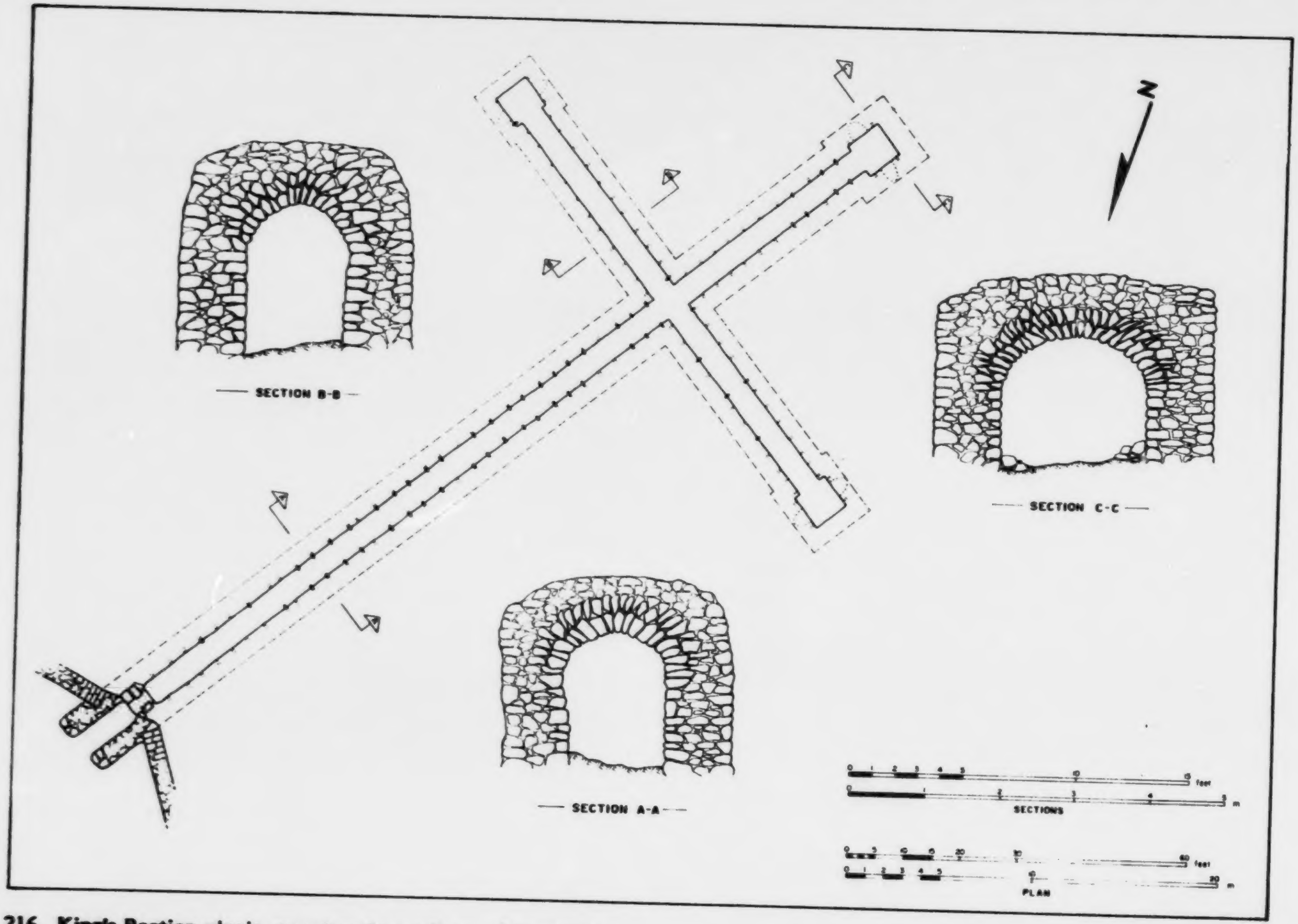
212 Princess Bastion. Proposed *éperon*, Verrier, 1737. The plan shows the retired battery commanding the beach in the direction of Black Rock, also the loopholed wall facing the shallows. If raised, the foldaway flap depicts the casemate beneath the ramparts (not shown here). The profile of the *éperon* shows the construction technique of sheathing walls with planks nailed to timbers held by iron clamps imbedded in the masonry. (Archives Nationales, Paris.)


VEÜE de l'Angle flanqué du Ba

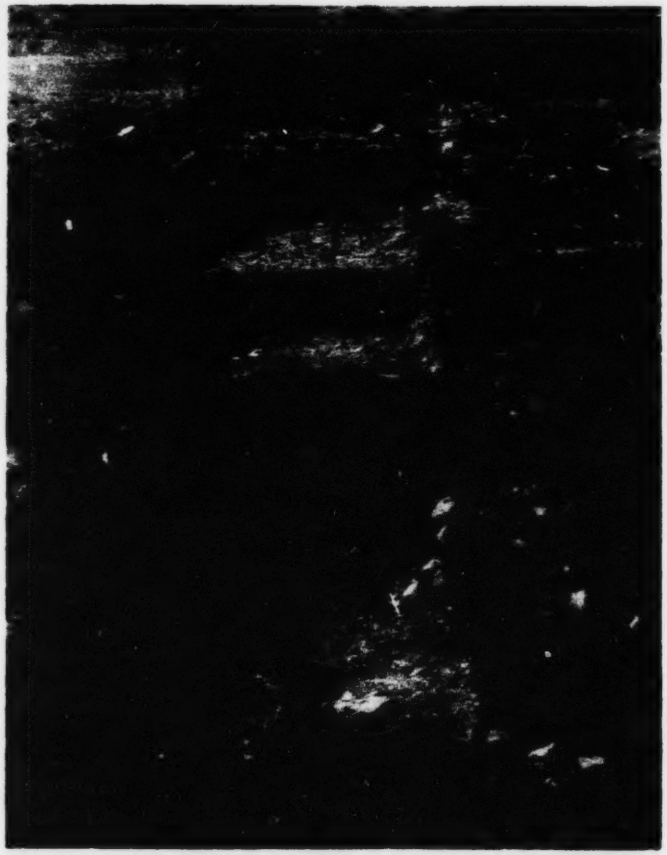
213 Princess Bastion. Detail from Figure 212. Palisades on the covered way are seen at left appearing above the crest of the glacis; *batardeau* closes off the end of the ditch. Note the rounded shape of the flanked angle. The inverted keyhole shape of the gun-loops is clearly depicted. Also of interest is the turf capping on the parapets, especially the merlons of the embrasures. (Archives Nationales, Paris.)

214 Princess Bastion. Coastline in 1963 when loophole was first exposed by erosion. (Fortress of Louisbourg NHP.)

215 Princess Bastion. Loophole as excavated. (Fortress of Louisbourg NHP.)

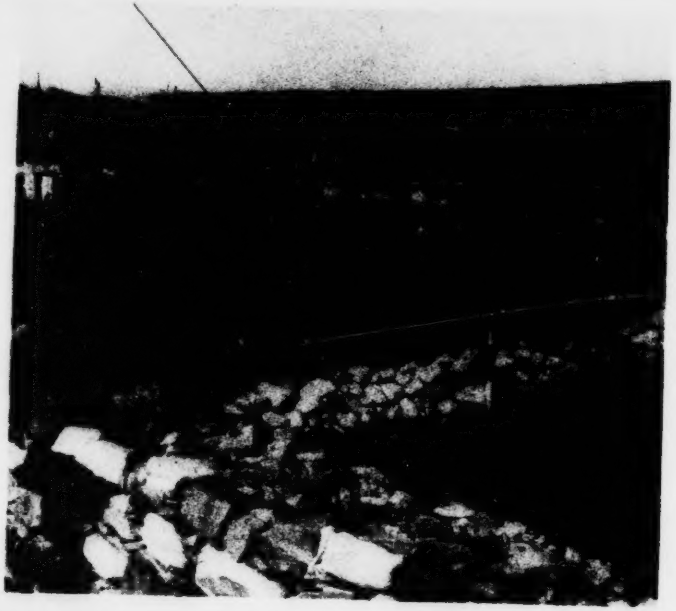

N
SECTION B-B
SECTION C-C
SECTION A-A
0 1 2 3 4 5 10 15 feet
0 1 2 3 4 5 m
SECTIONS
0 5 10 15 20 30 60 feet
0 1 2 3 4 5 10 20 m
PLAN

216 **King's Bastion** glacis, countermine gallery. (Drawing by T.M. Smith.)



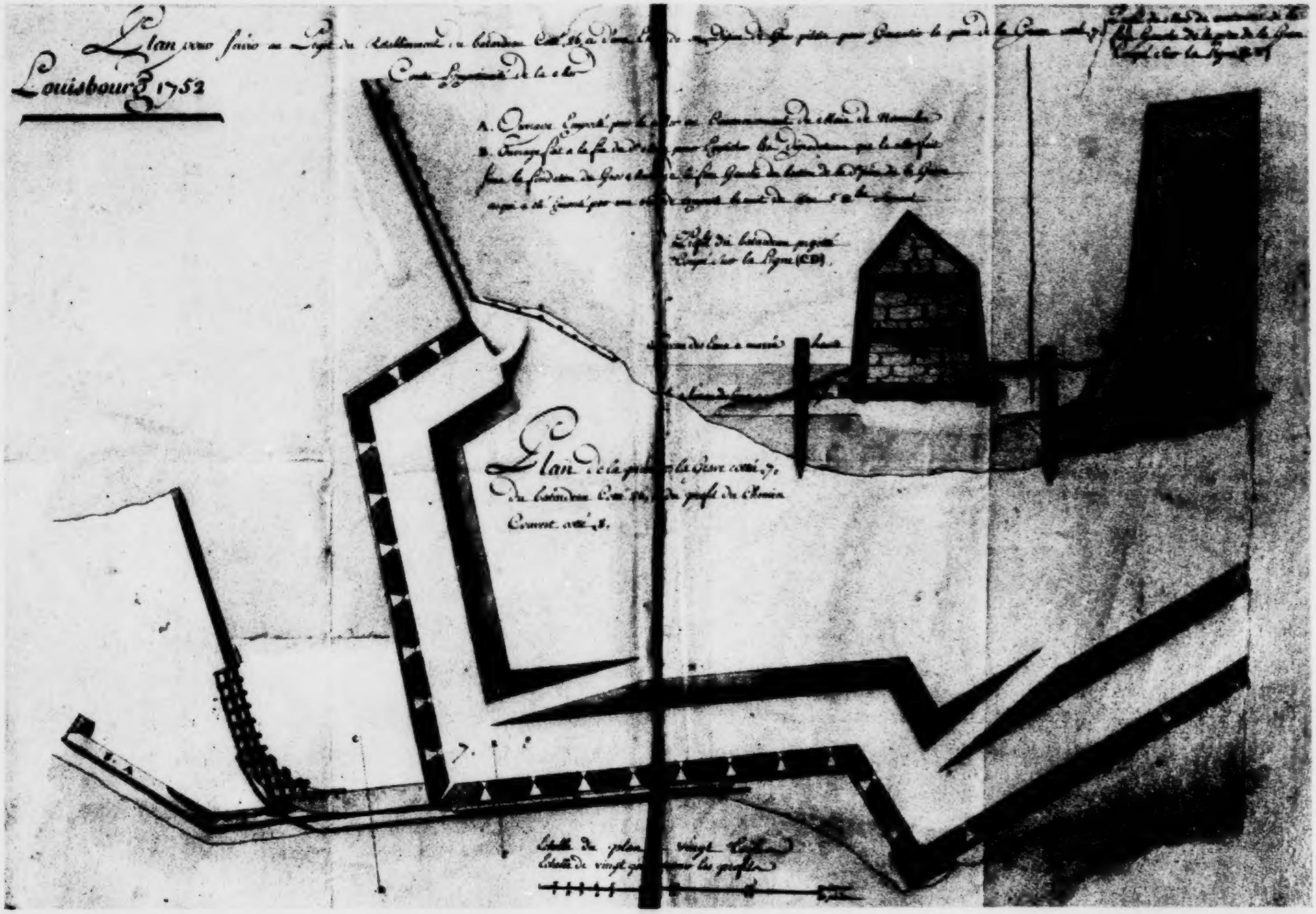
217 **Outworks.** Counterscarp and covered way revetment in front of King's Bastion, as excavated. Note broken ground and commanding heights beyond glacis. (Fortress of Louisbourg NHP.)

218 **Mont-Louis.** Traverse on covered way. (Photo by author.)

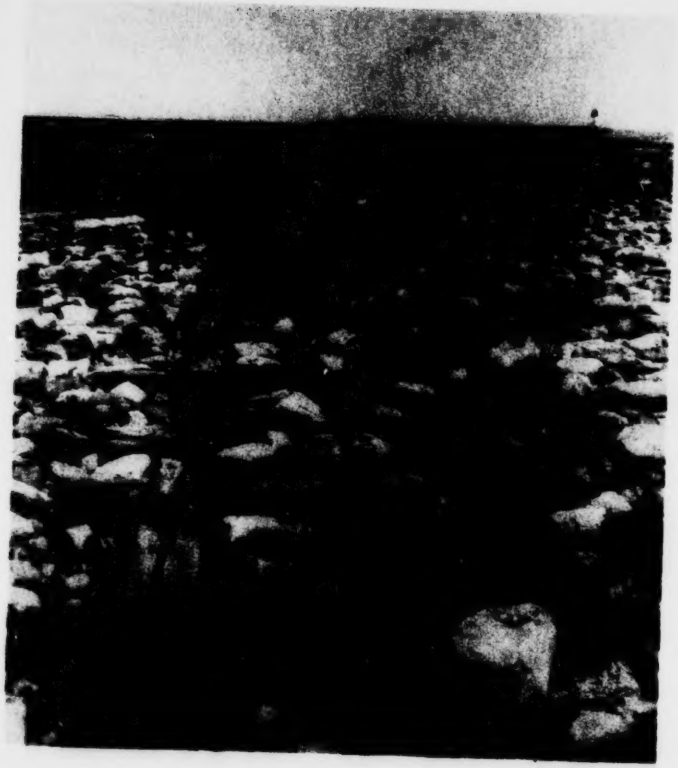


219 Outworks. Traverse or *épaulement* built in ditch parallel to right flank of King's Bastion. Note drystone revetment on side nearest bastion, foreground; also use of rocks as fill beneath topsoil covering. (Fortress of Louisbourg NHP.)

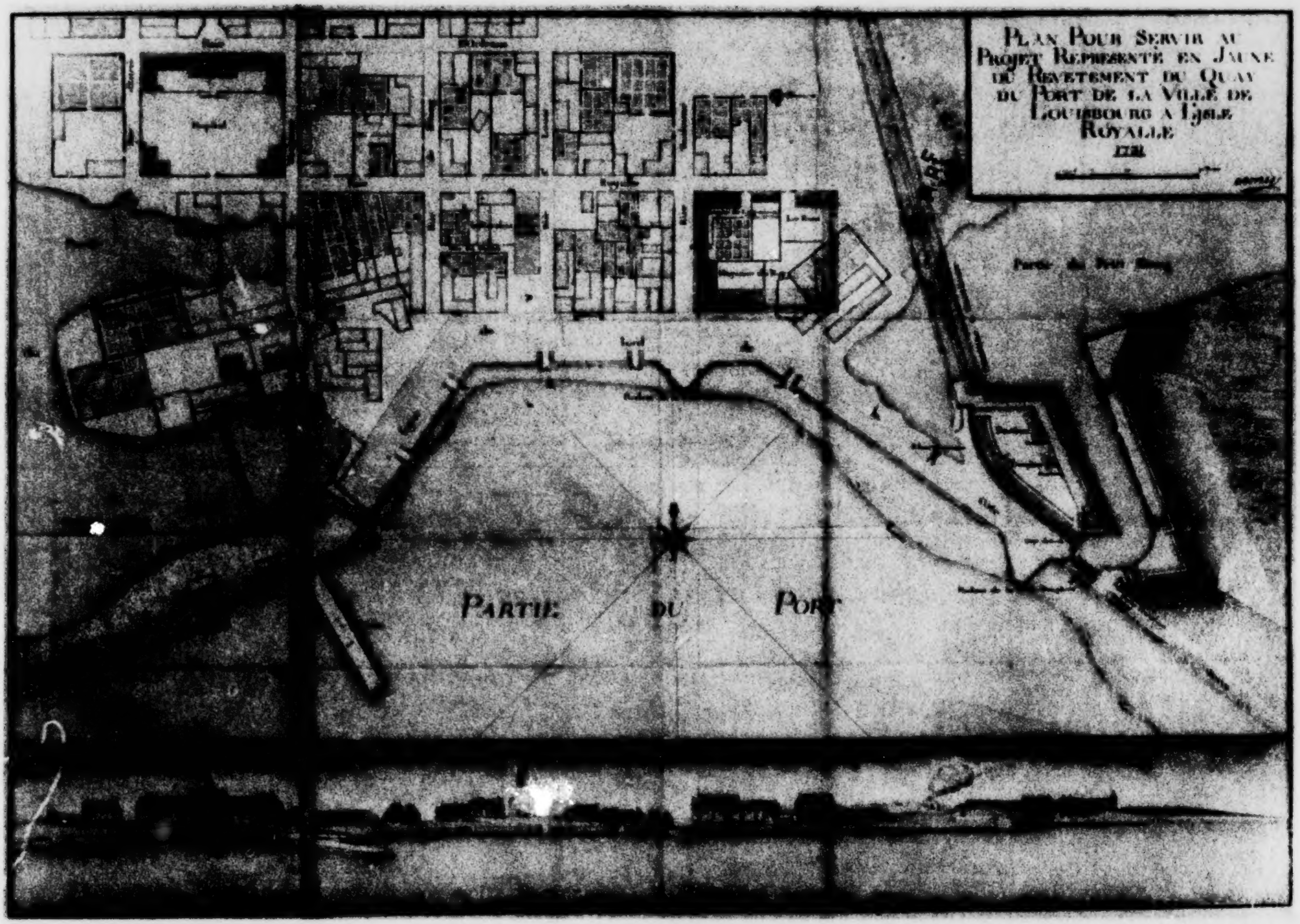
220 Quay Wall adjoining *batardeau* of Dauphin Bastion; ashlar masonry with recesses to receive timber uprights to which planks were nailed. Remains of Circular Battery and passage behind Dauphin Gate in background. (Fortress of Louisbourg NHP.)


Louisbourg 1752
Profil du batardeau projeté Coupé sur la ligne (CD)

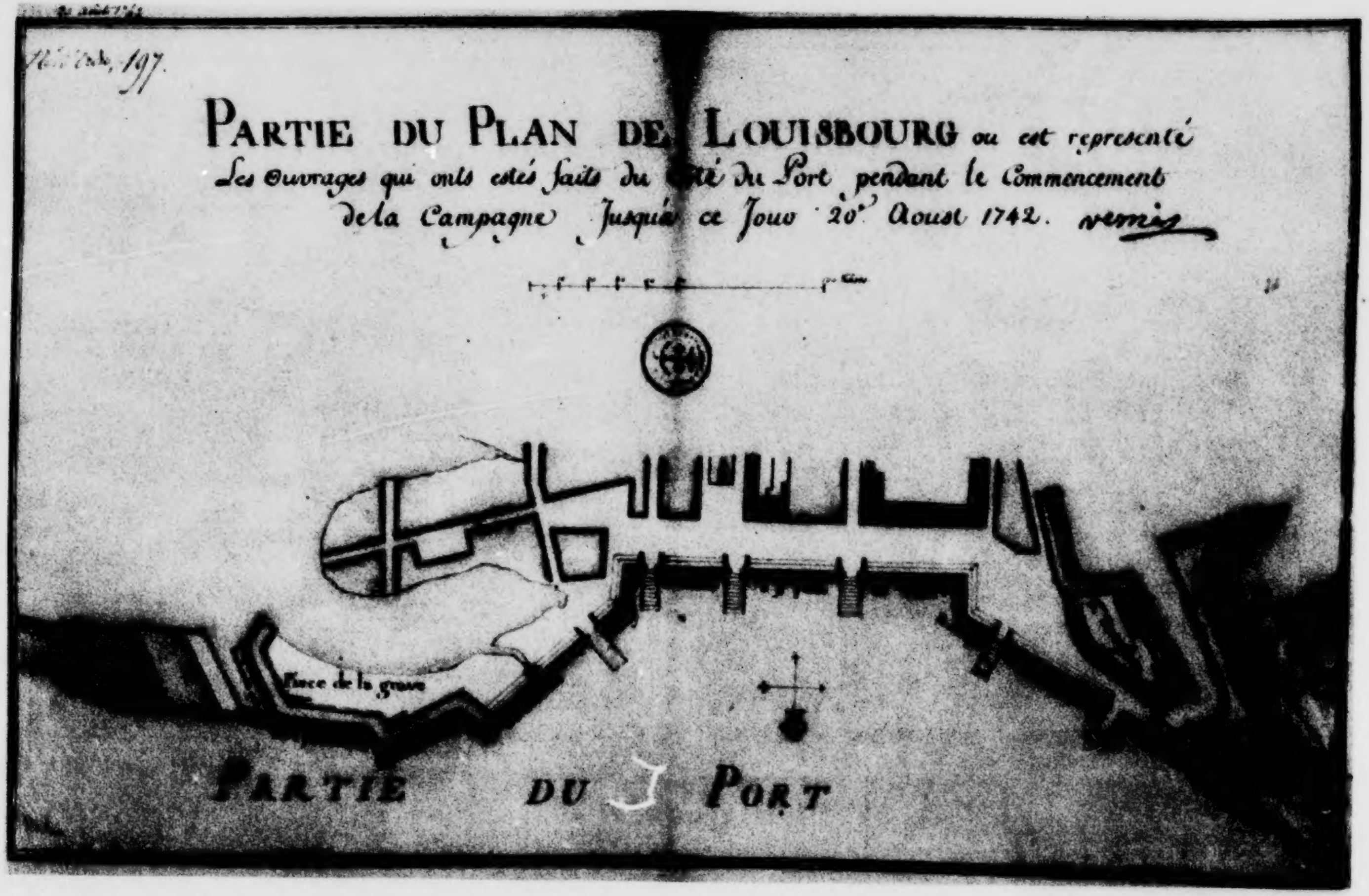
221 Pièce de la Grave. Breakwater proposed by Franquet to reduce damage to the ramparts. (Archives Nationales, Paris.)



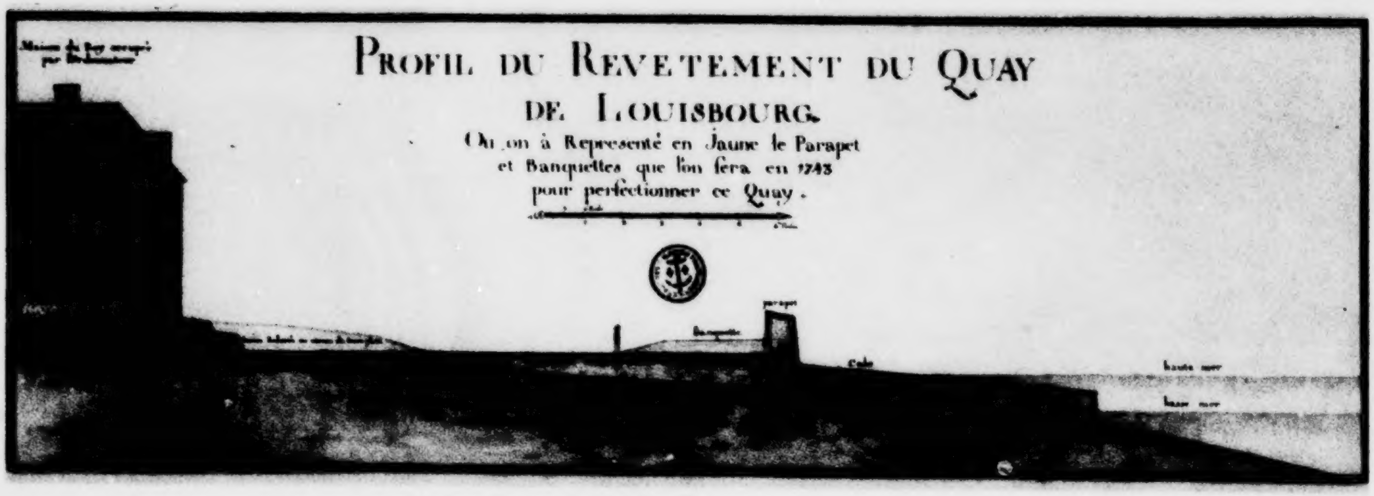
222 Pièce de la Grave. Timber cribwork, presumably the foundations of Franquet's breakwater, exposed during extremely low tides. (Fortress of Louisbourg NHP.)


Plan Pour Servir au
Projet Representé en Jaune
du Revetement du Quay
du Port de la Ville de
Louisbourg a l'Isle
Royalle
1731
Partie du Port

223 Quay. Early proposals, Verrier, 1731. (Archives du Génie, Vincennes.)

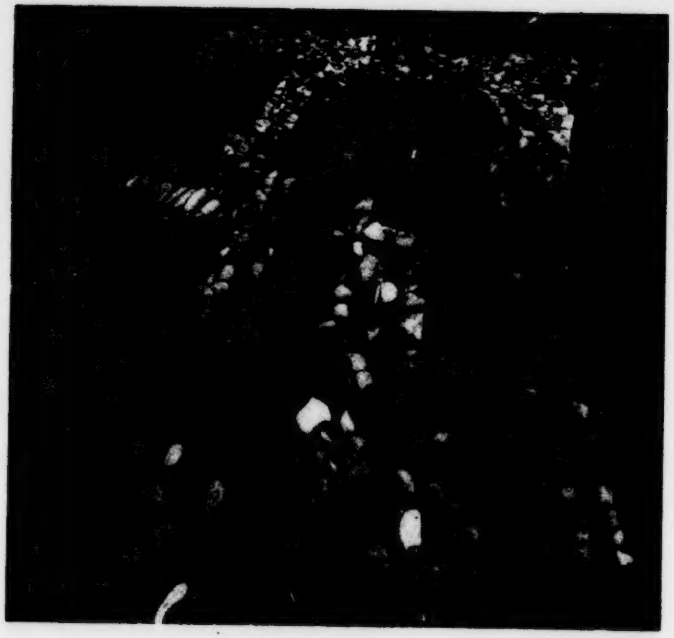

197
Partie du Plan de Louisbourg ou est representé
Les Ouvrages qui onts estés faits du Costé du Port pendant le Commencement
de la Campagne Jusqu'à ce Jour 20e Aoust 1742. Verrier
Pièce de la grave
Partie du Port

224 Quay. Construction progress and revised proposals, Verrier, 1742. The Pièce de la Grave and the *éperon* of the Dauphin Bastion are shown as completed works. (Archives Nationales, Paris.)

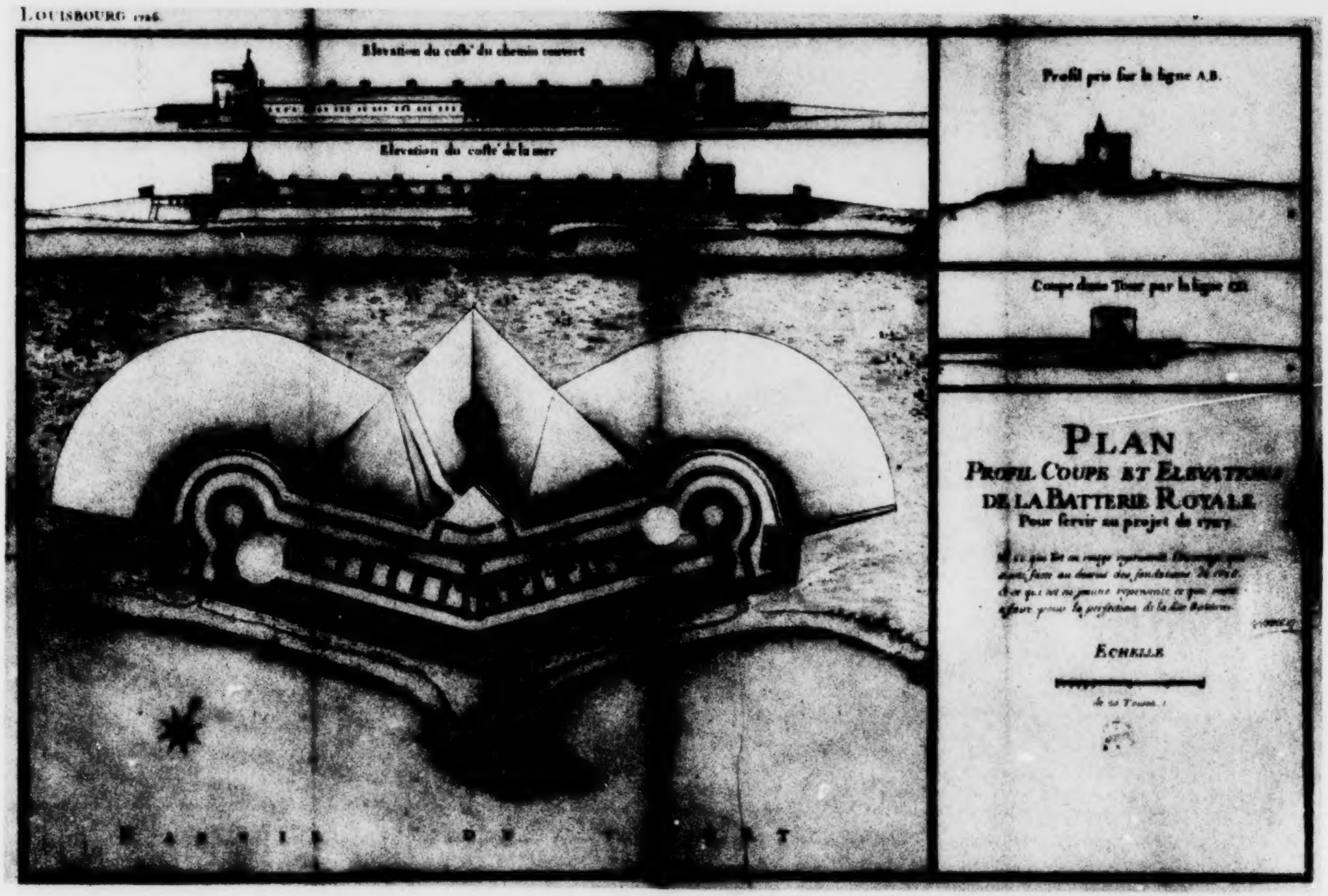

PROFIL DU REVETEMENT DU QUAY
DE LOUISBOURG.
Ou l'on à Representé en Jaune le Parapet
et Banquettes que l'on fera en 1743
pour perfectionner ce Quay.
parapet
Banquette
Cale
haute mer
basse mer

225 Quay. Section through wall with slipway in background, 1743. (Archives Nationales, Paris.)

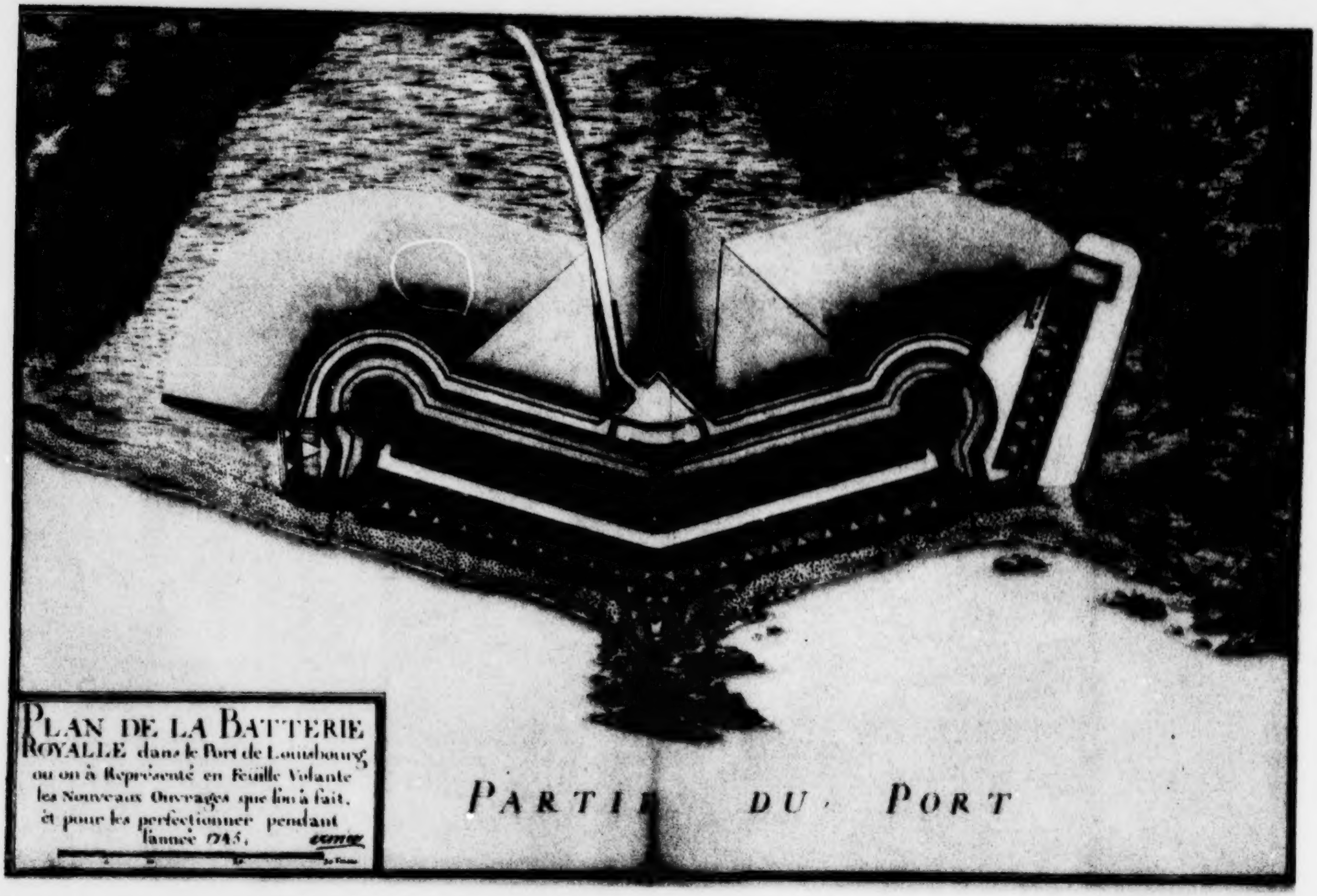
226 Quay. Right re-entrant angle as excavated; gateway and pilings for Cale de la Halle at right. Note plank revetting at base of masonry, also recesses for timber uprights. (Fortress of Louisbourg NHP.)



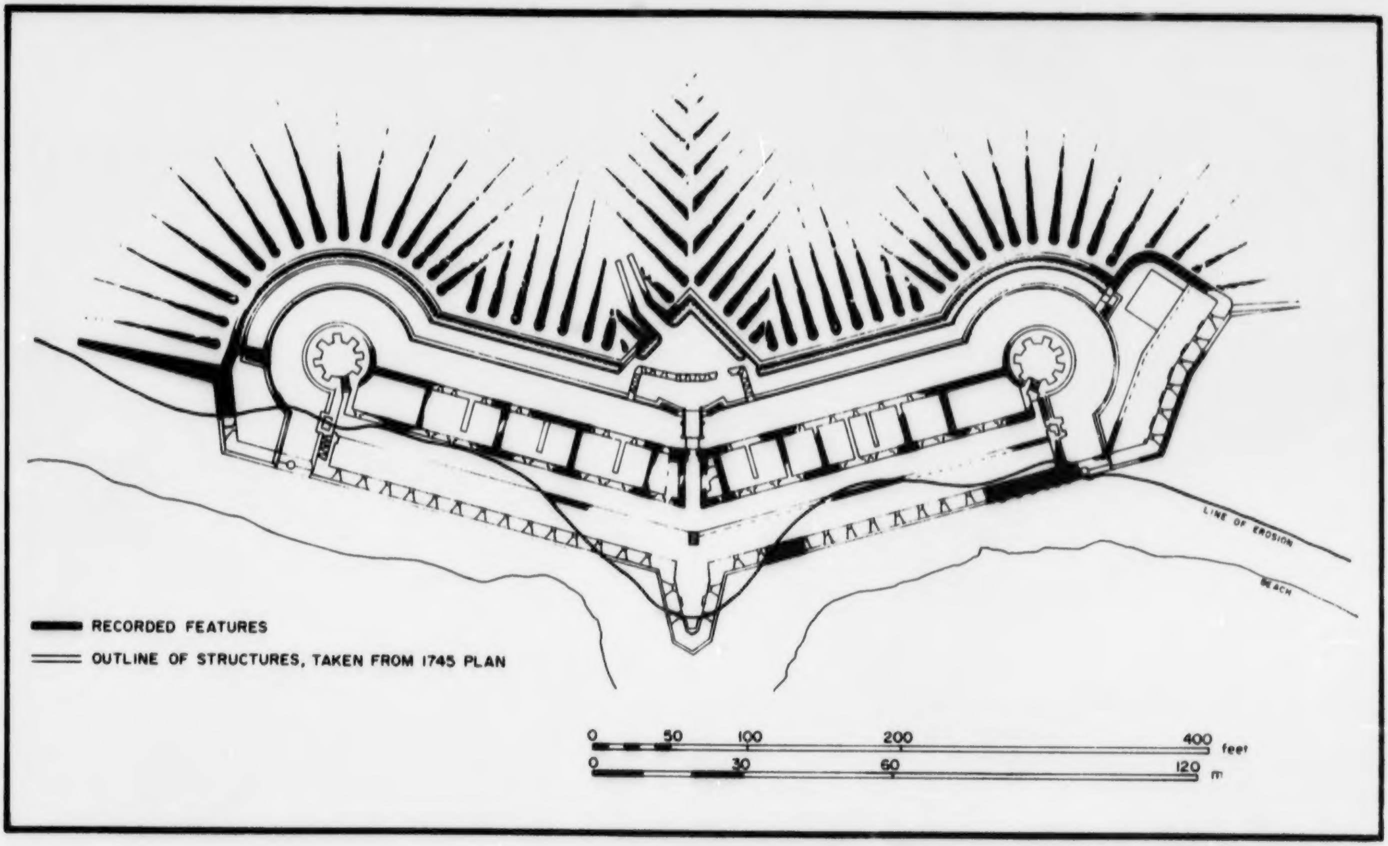
227 Quay. Cale de l'intendance and junction with Rue Toulouse, viewed from the town; quay revetment and wooden pilings in background. Note series of rubble and brick drains in road surface. (Fortress of Louisbourg NHP.)


LOUISBOURG 1726.
Elevation du costé du chemin couvert
Elevation du costé de la mer
Profil pris sur la ligne A.B.
Coupe d'une Tour par la ligne CD
PLAN
PROFIL COUPE ET ELEVATIONS
DE LA BATTERIE ROYALE
Pour servir au projet de 1727
ECHELLE
de 10 Toises

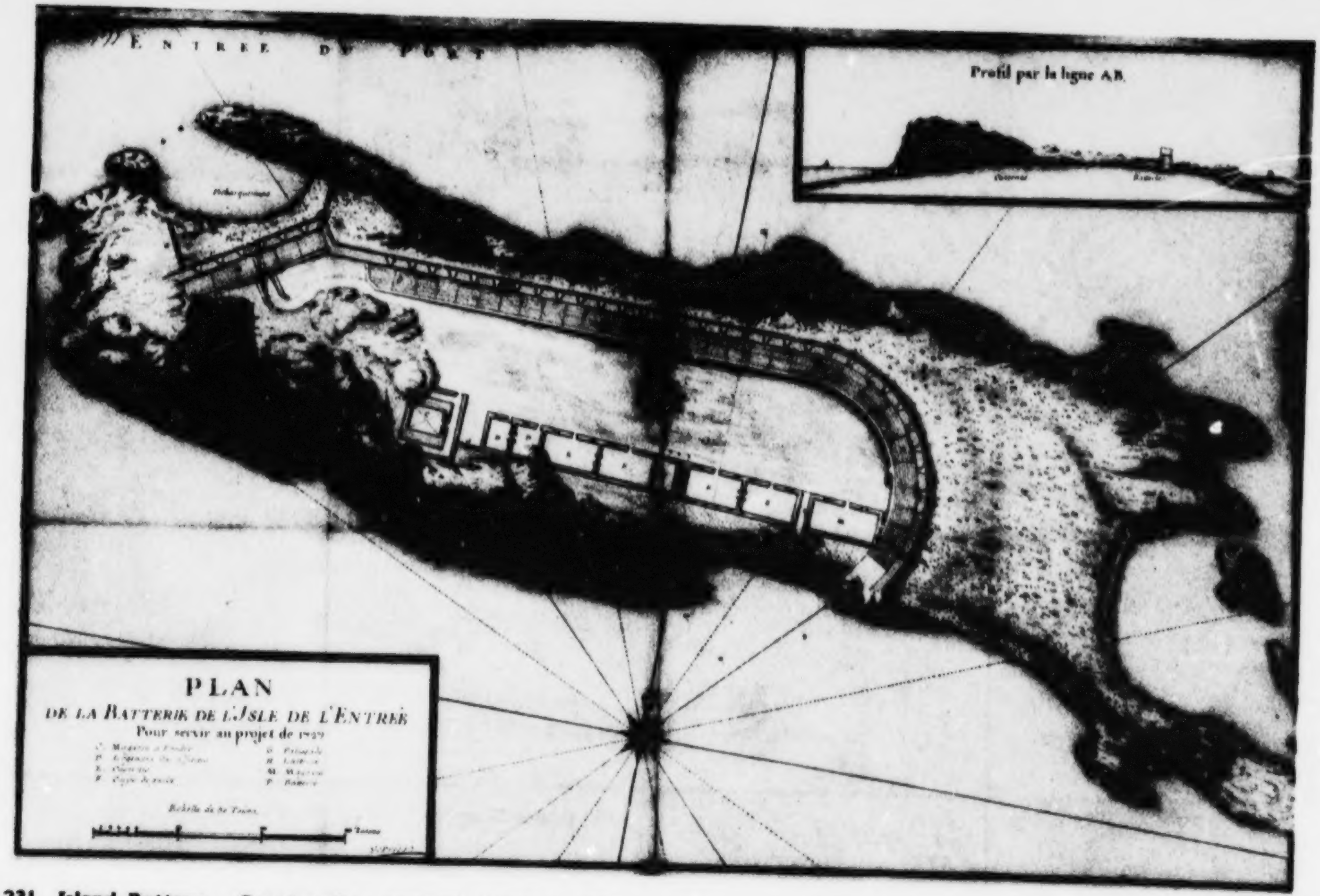
228 Royal Battery. Construction proposals, Verrier, 1726. The basic design thereafter remained unchanged throughout the entire period of occupation. (Archives Nationales, Paris.)


PLAN DE LA BATTERIE
ROYALLE dans le Port de Louisbourg,
ou on à Représenté en Feuille Volante
les Nouveaux Ouvrages que l'on à fait,
èt pour les perfectionner pendant
l'année 1745,
PARTIE DU PORT

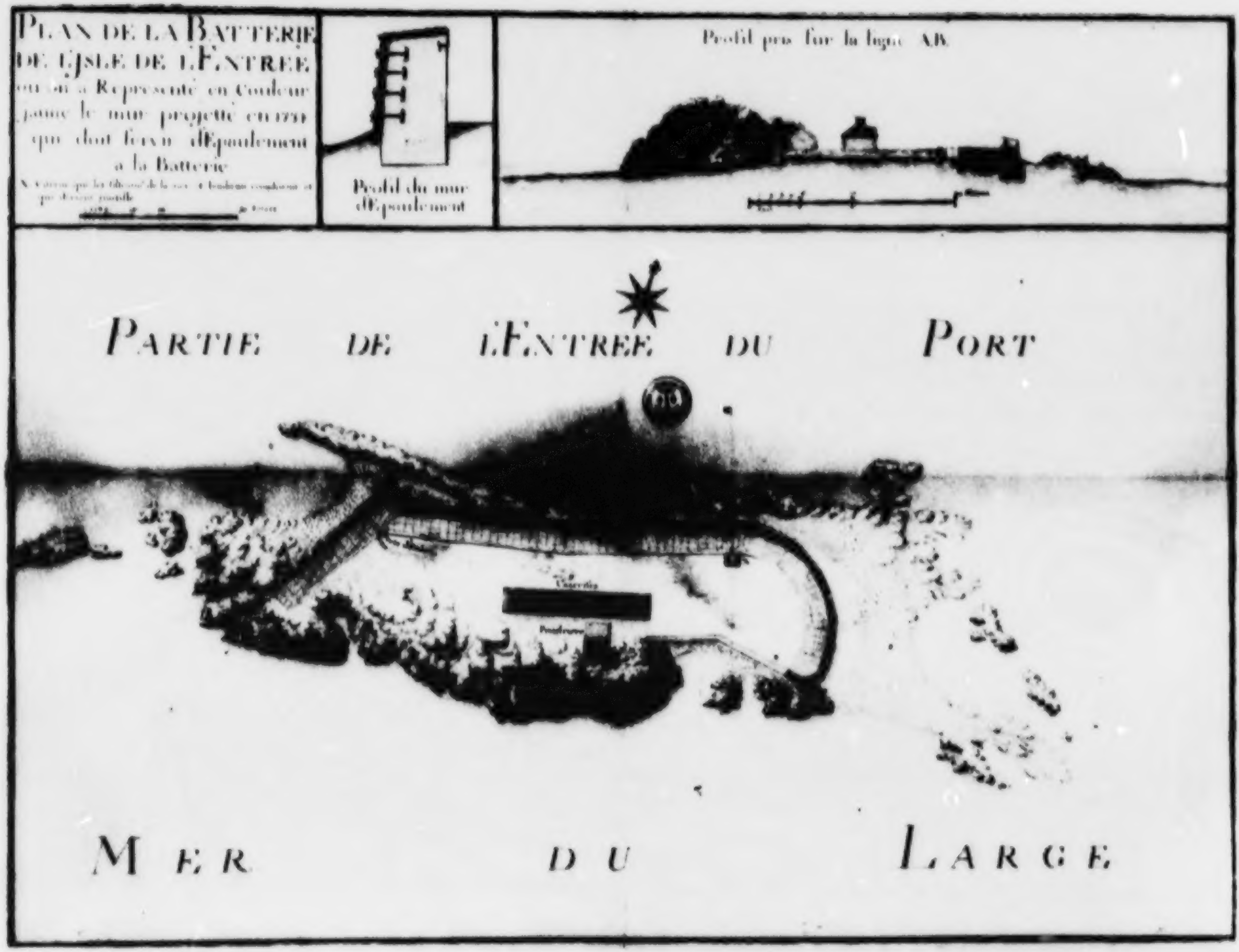
229 Royal Battery. Additional defences, Verrier, 1745. The work proposed was the *éperon* at the salient and extension to left flank; note also a loophole wall extending from new flank to counterscarp in front of tower. Towers are depicted with roofs, presumably of wooden shingles. (Archives Nationales, Paris.)


LINE OF EROSION
BEACH
RECORDED FEATURES
OUTLINE OF STRUCTURES, TAKEN FROM 1745 PLAN
0 50 100 200 400 feet
0 30 60 120 m

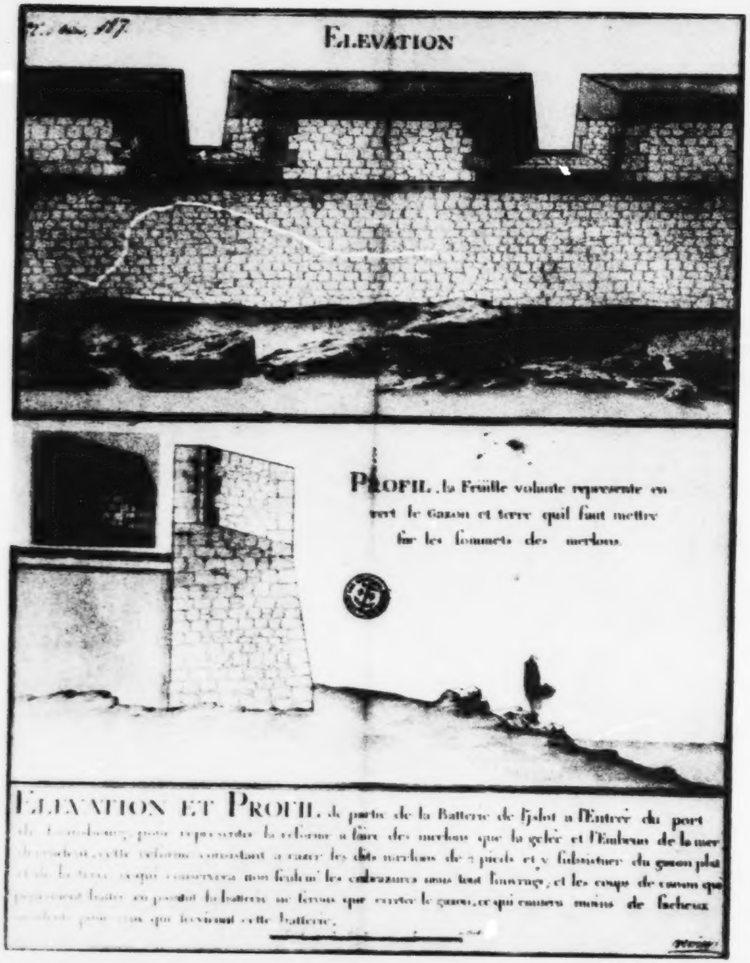
230 Royal Battery. (Drawing by T.M. Smith.)


ENTRÉE DU PORT
Profil par la ligne AB.
PLAN
DE LA BATTERIE DE L'ISLE DE L'ENTRÉE
Pour servir au projet de
Echelle de Toises

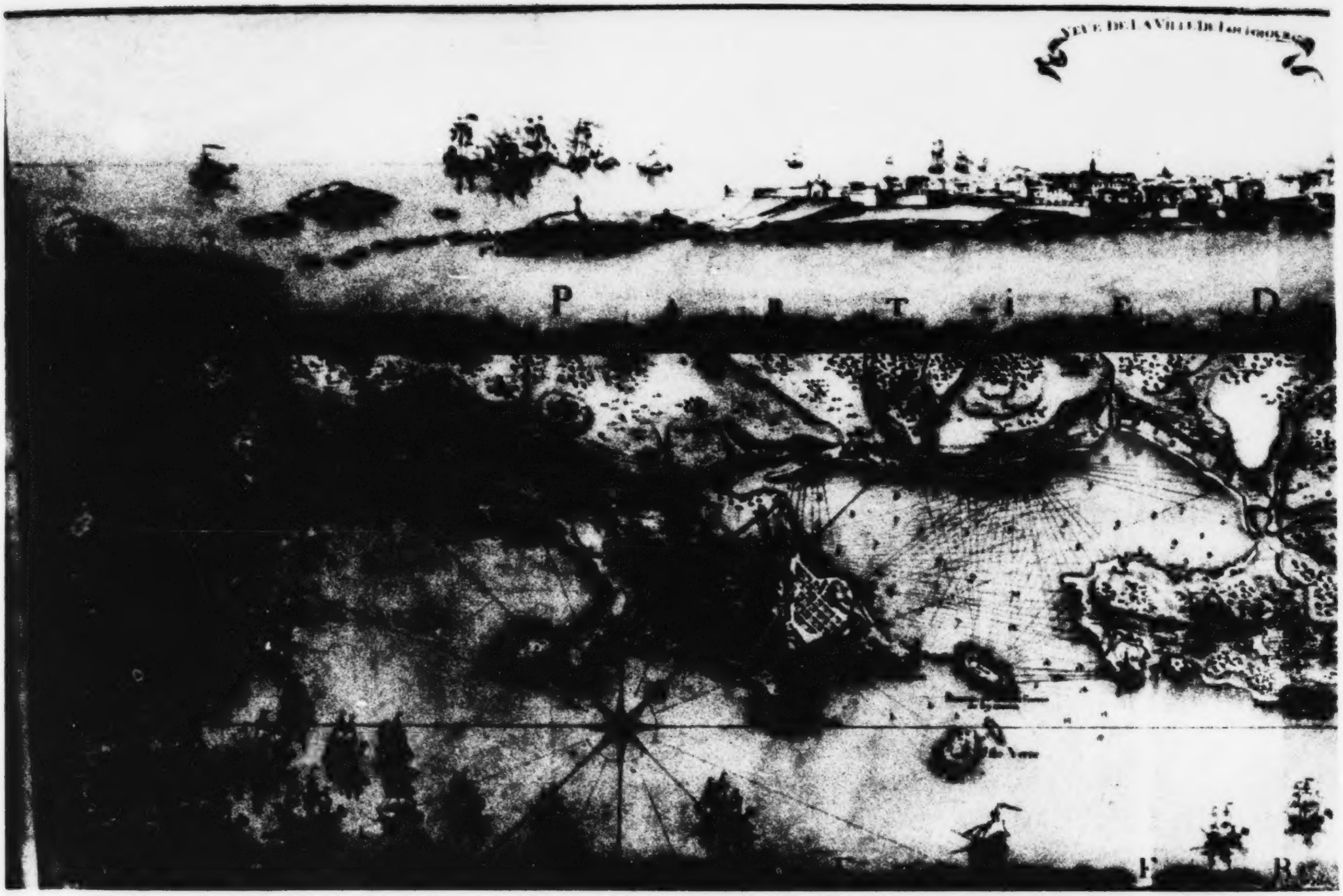
231 **Island Battery.** Construction proposal, Verrier, 1726. (Archives Nationales, Paris.)


Plan de la Batterie de l'Isle de l'Entree
ou on a Representé en Couleur jaune le mur projetté en 1734 qui doit servir d'Epaulement a la Batterie
Profil du mur d'Epaulement
Profil pris sur la ligne AB
Partie de l'Entree du Port
Mer du Large

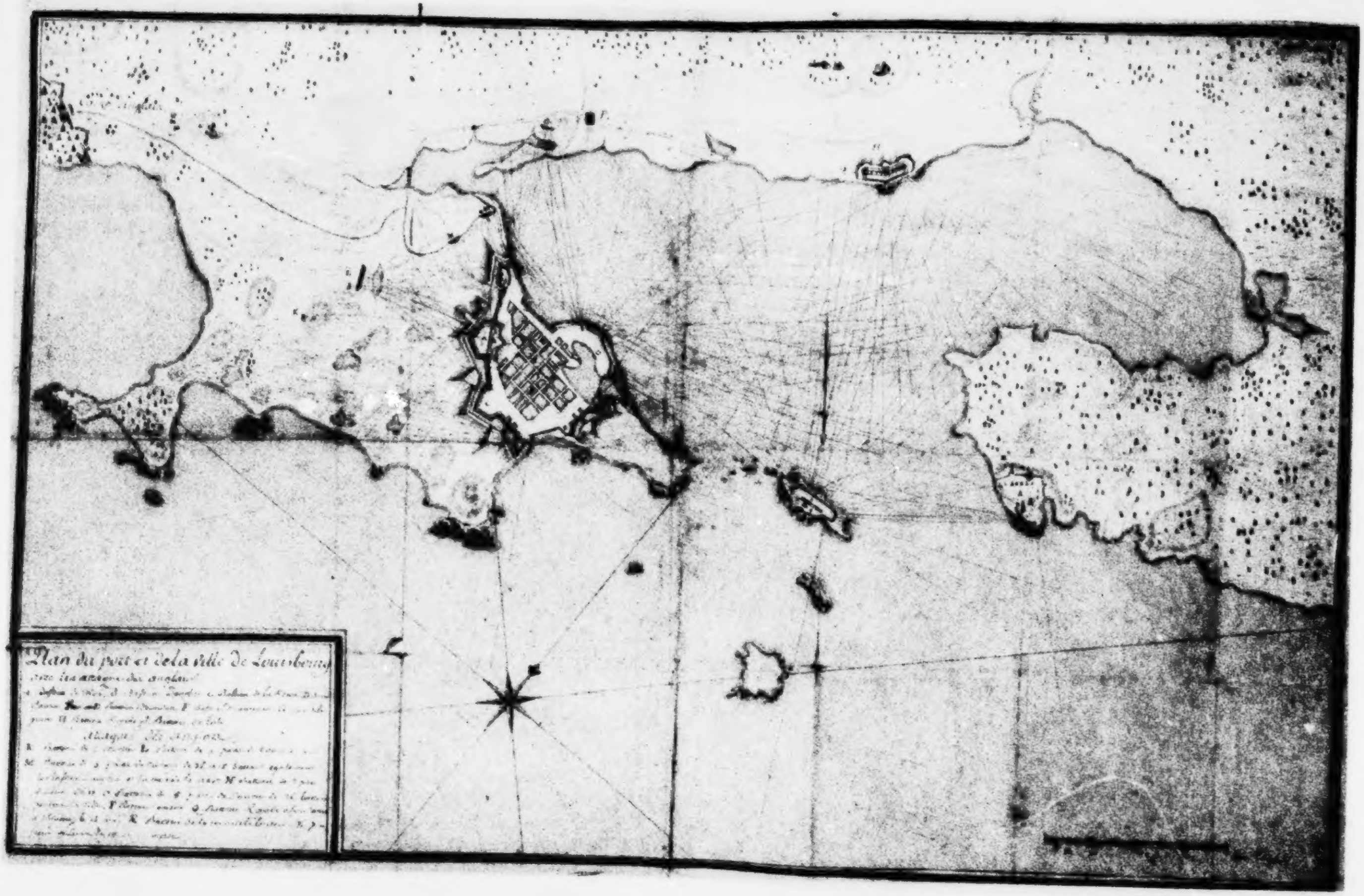
232 Island Battery. Modifications and additions, 1734. (Archives Nationales, Paris.)


ELEVATION
PROFIL. la Feuille volante represente en vert le Gazon et terre quil faut mettre sur les sommets des merlons.
ELEVATION ET PROFIL de partie de la Batterie de l'Islot a l'Entrée du port

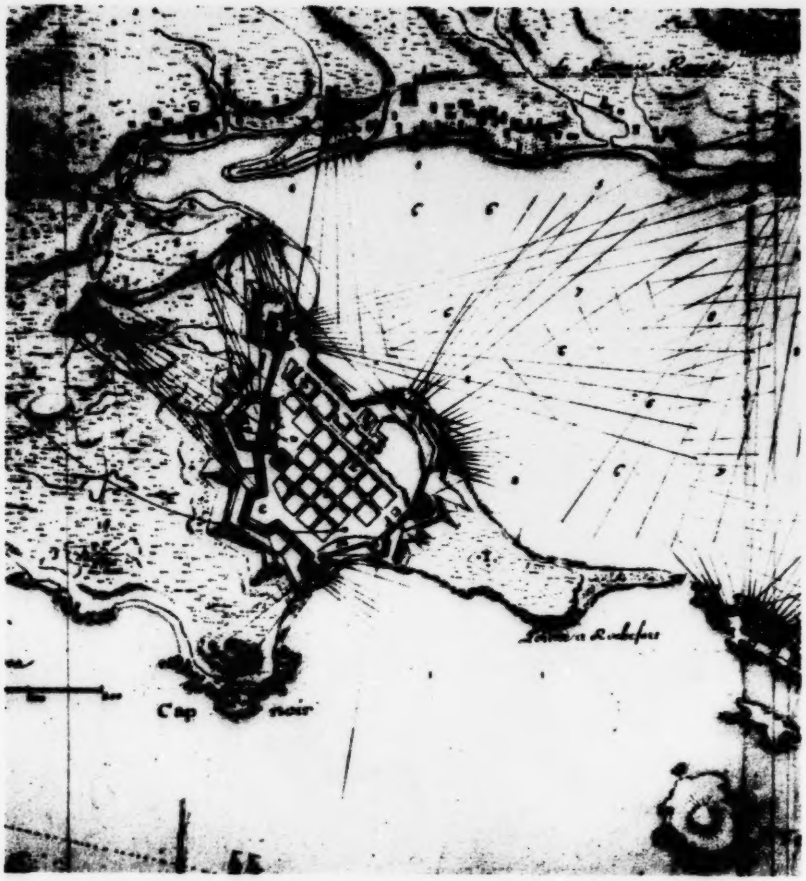
233 Island Battery. Repair and modifications to parapet, Verrier, 1735. Elevation view shows masonry of exterior revetment and slope of parapet reduced by two *pieds* and replaced with turf; inset shows this technique in section. (Archives Nationales, Paris.)


VEUE DE LA VILLE DE LOUISBOURG
PARTIE D
F R

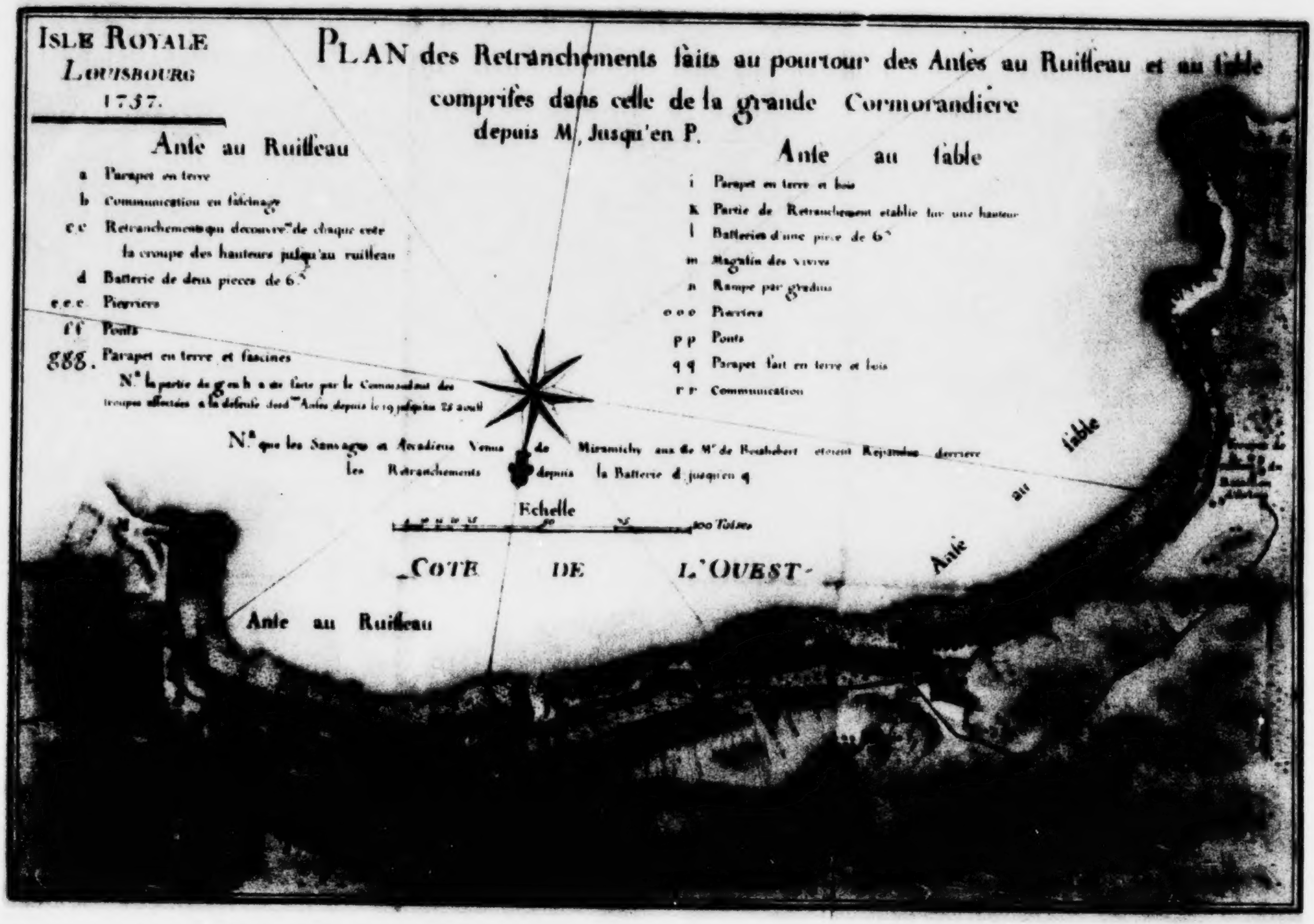
234 1745 siege. English landing in Gabarus Bay is shown, with encampment at Flat Point (Pointe Platte). Note batteries and trench in front of King's and Dauphin bastions, also battery firing across harbour. (Original source unknown; copy on file Fortress of Louisbourg NHP.)


Plan du port et de la ville de Louisbourg
avec les attaques des anglais

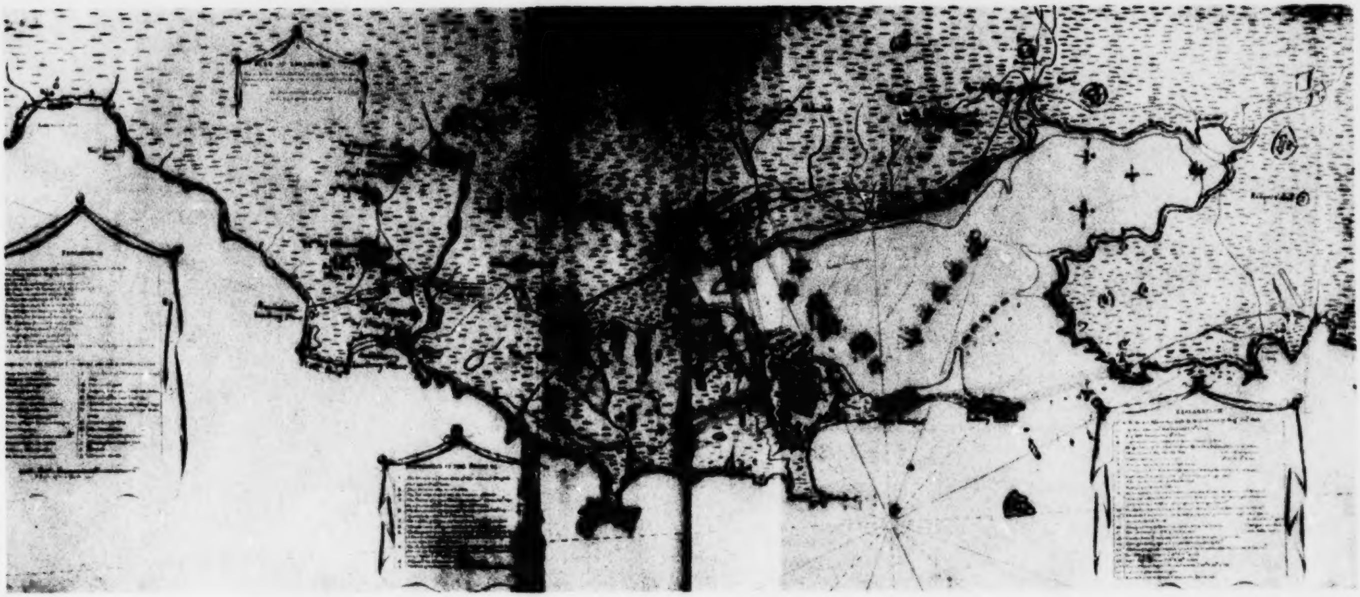
235 1745 siege. General plan of town and harbour with surrounding siegeworks. (Archives du Génie, Vincennes.)



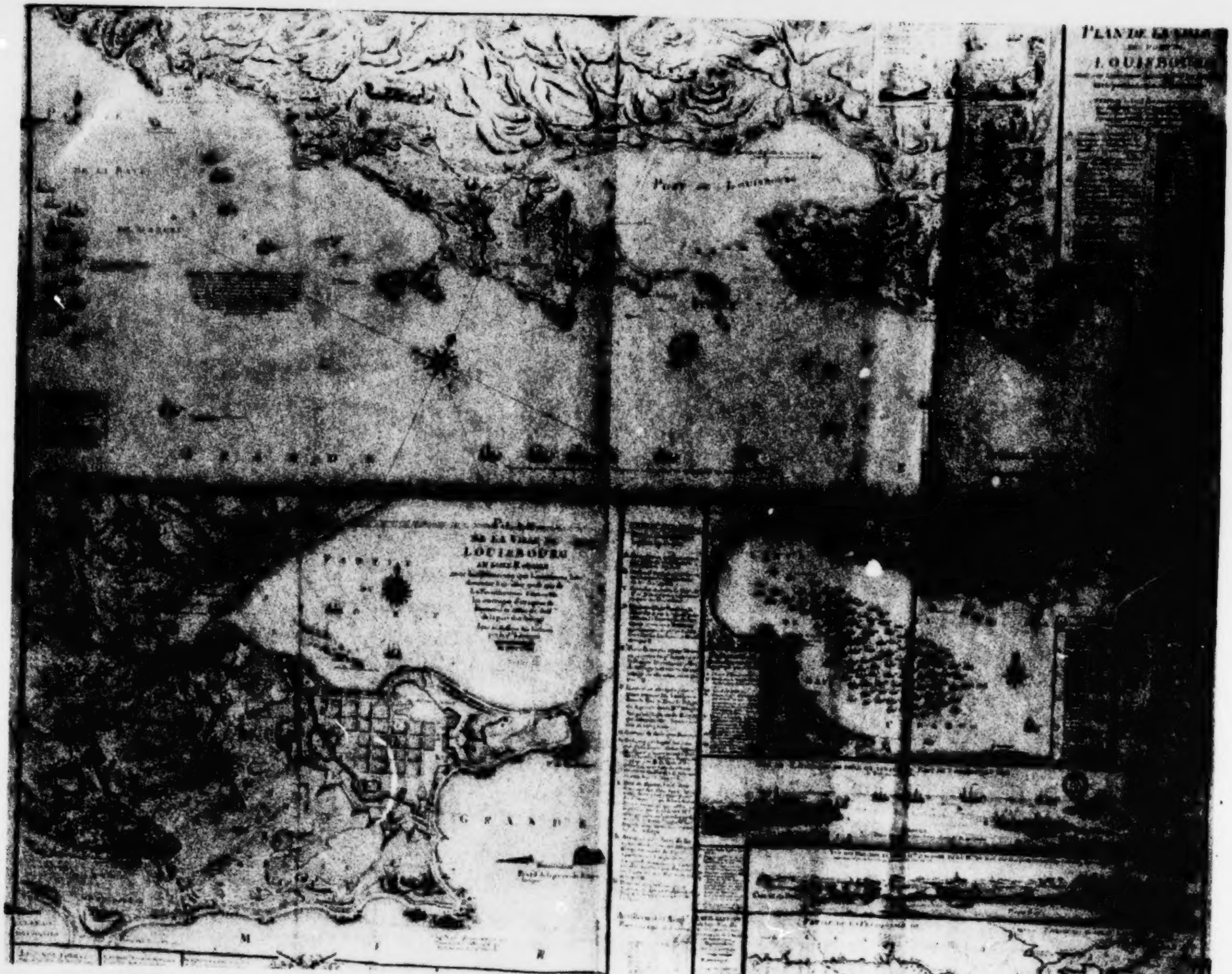
236 1745 siege. Batteries firing on King's and Dauphin bastions. S, battery of mortars and cannon, presumably on Rabasse Heights; V, T, advanced batteries. Titcomb's battery (Martissan Heights) is firing at the Dauphin Bastion across harbour. As depicted, the hills bear little relation to actual topography: Rabasse property would have been closer to Barachois and advanced battery T on another knoll (lime-kiln hill) near the Dauphin Bastion. (Original source unknown; copy on file Fortress of Louisbourg NHP.)


ISLE ROYALE
LOUISBOURG
1757.
PLAN des Retranchements ſaits au pourtour des Anses au Ruiſſeau et au ſable
compriſes dans celle de la grande Cormorandiere
depuis M, Jusqu'en P.
Anse au Ruiſſeau
a Parapet en terre
b Communication en ſaſcinage
c c Retranchements qui decouvre de chaque coté la croupe des hauteurs jusqu'au ruiſſeau
d Batterie de deux pieces de 6.
e e e Pierriers
f f Ponts
g g g. Parapet en terre et faſcines
Anse au ſable
i Parapet en terre et bois
k Partie de Retranchement etablie ſur une hauteur
l Batteries d'une piece de 6.
m Magazin des vivres
n Rampe par gradins
o o o Pierriers
p p Ponts
q q Parapet fait en terre et bois
r r Communication
Echelle
100 Toises
COTE DE L'OUEST
Anse au Ruiſſeau
Anse au ſable

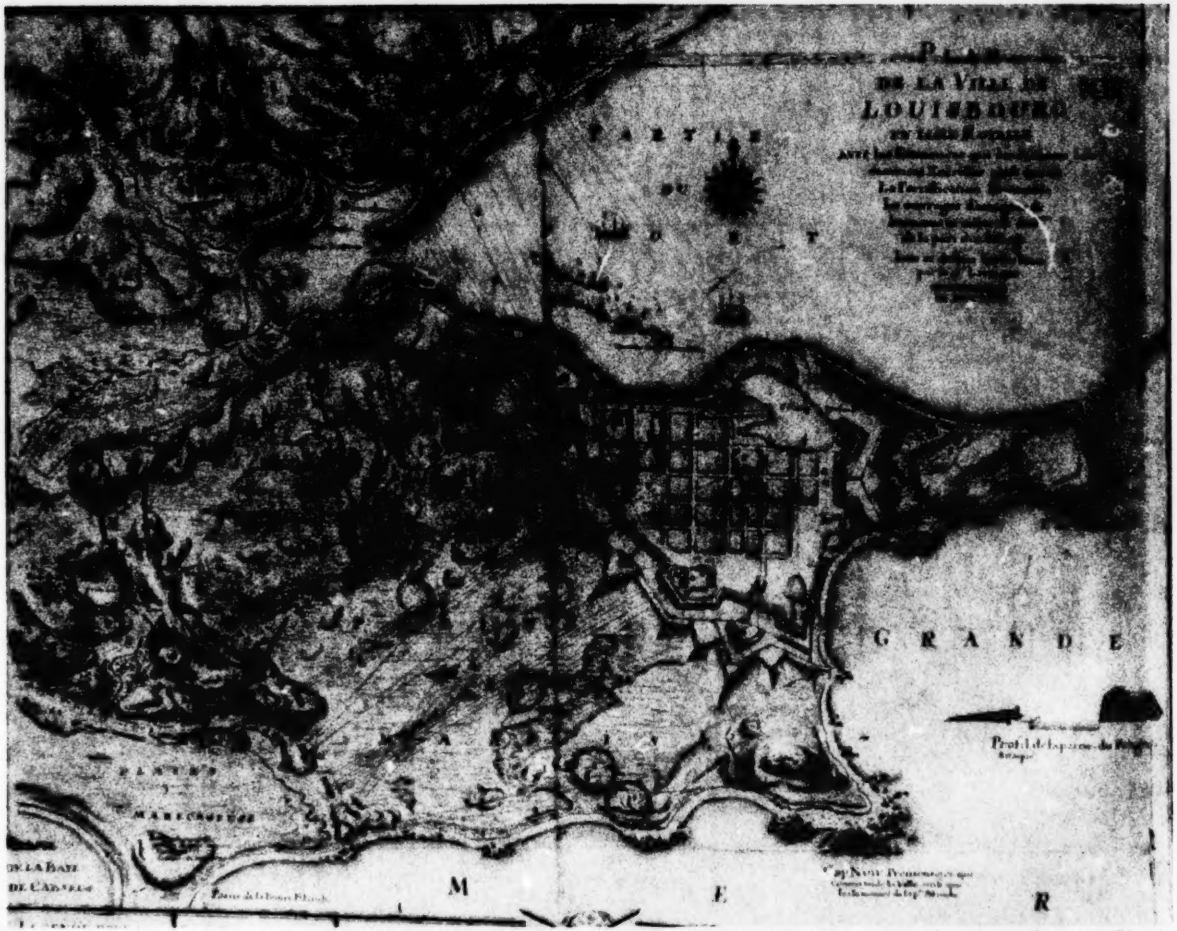
237 **Preparations against an enemy landing.** Kennington Cove positions, 1757. (Archives Nationales, Paris.)



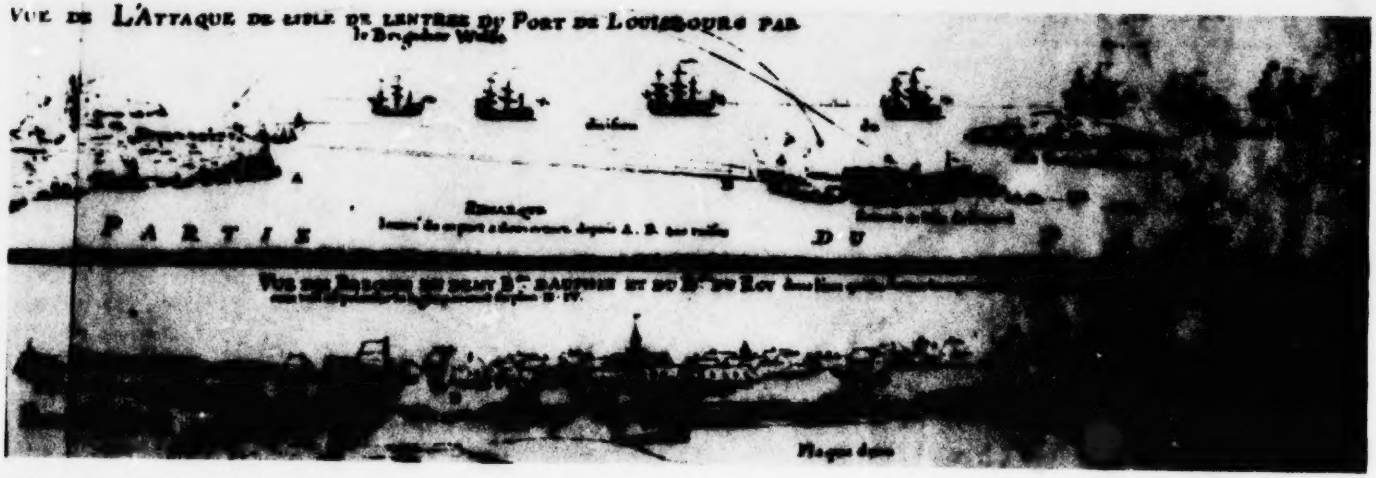
238 1758 siege. Disposition of British camps and redoubts, Samuel Holland. (Public Archives Canada, H3/240.)



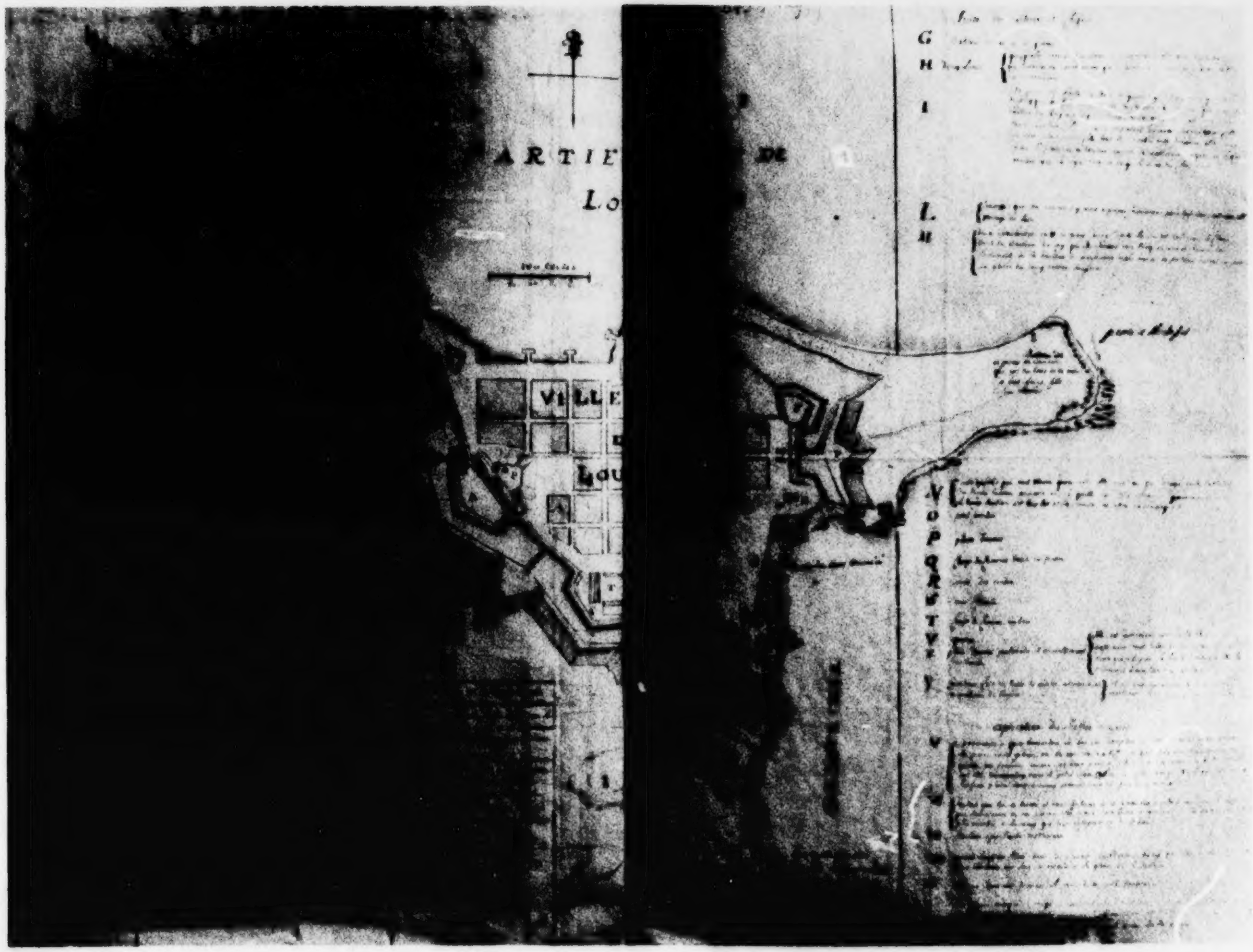
239 1758 siege. Plan and views of British attack, Lartigue. (Bibliothèque Nationale, Paris.)


Plan
de la Ville de
LOUISBOURG
PARTIE DU PORT
GRANDE
A
M
E
R

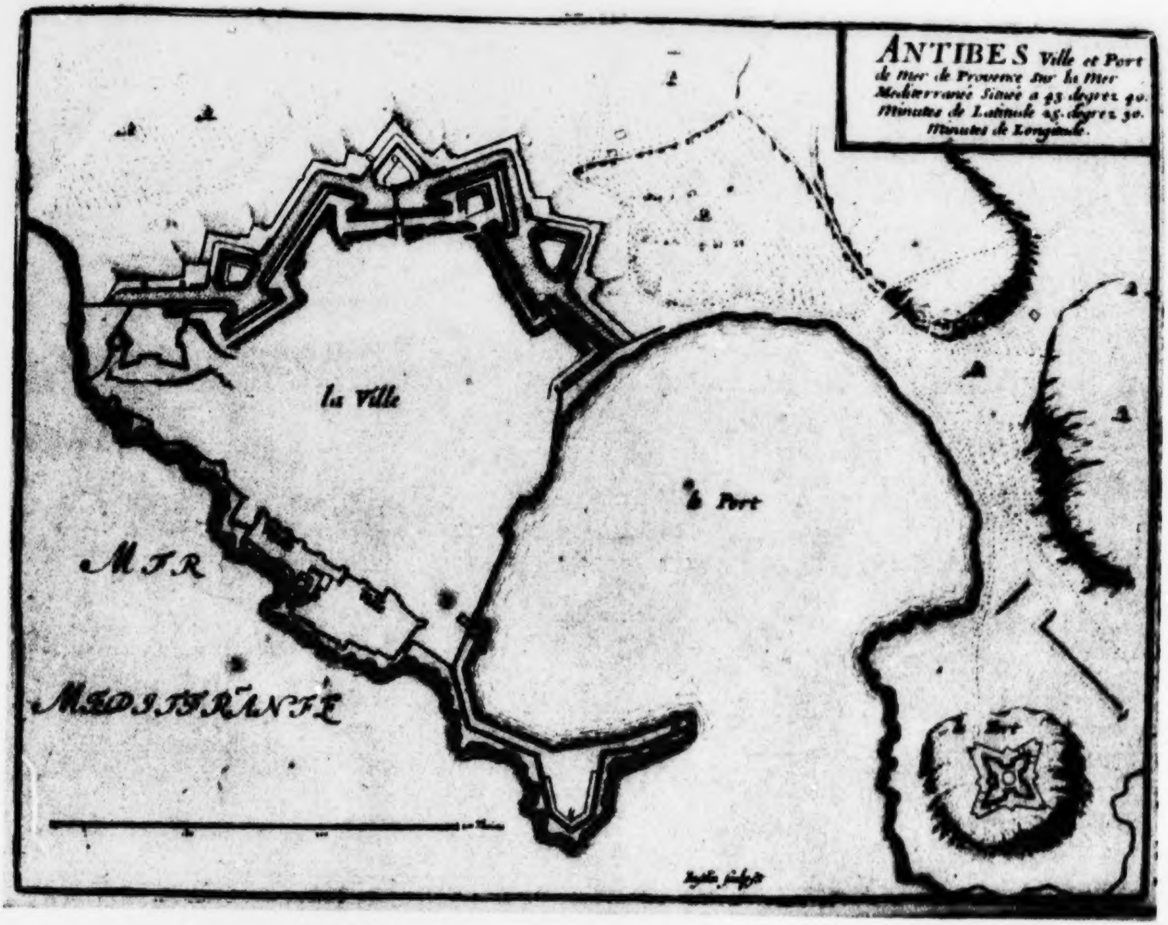
240 1758 siege. Detail from Figure 239. Note disposition of British batteries and trenches. Green Hill is at A (small circle), "La Grande Butte à Brissonet." French batteries (large circles) commanding the coastal approaches to Black Rock are on the knolls south of the *marais*. (Bibliothèque Nationale, Paris.)


VUE DE L'ATTAQUE DE LISLE DE LENTREE DU PORT DE LOUISBOURG PAR
le Brigadier Wolfe
A
Remarque
PARTIE
DU
VUE DES BRECHES DU DEMY Bon DAUPHIN ET DU Bon DU ROY

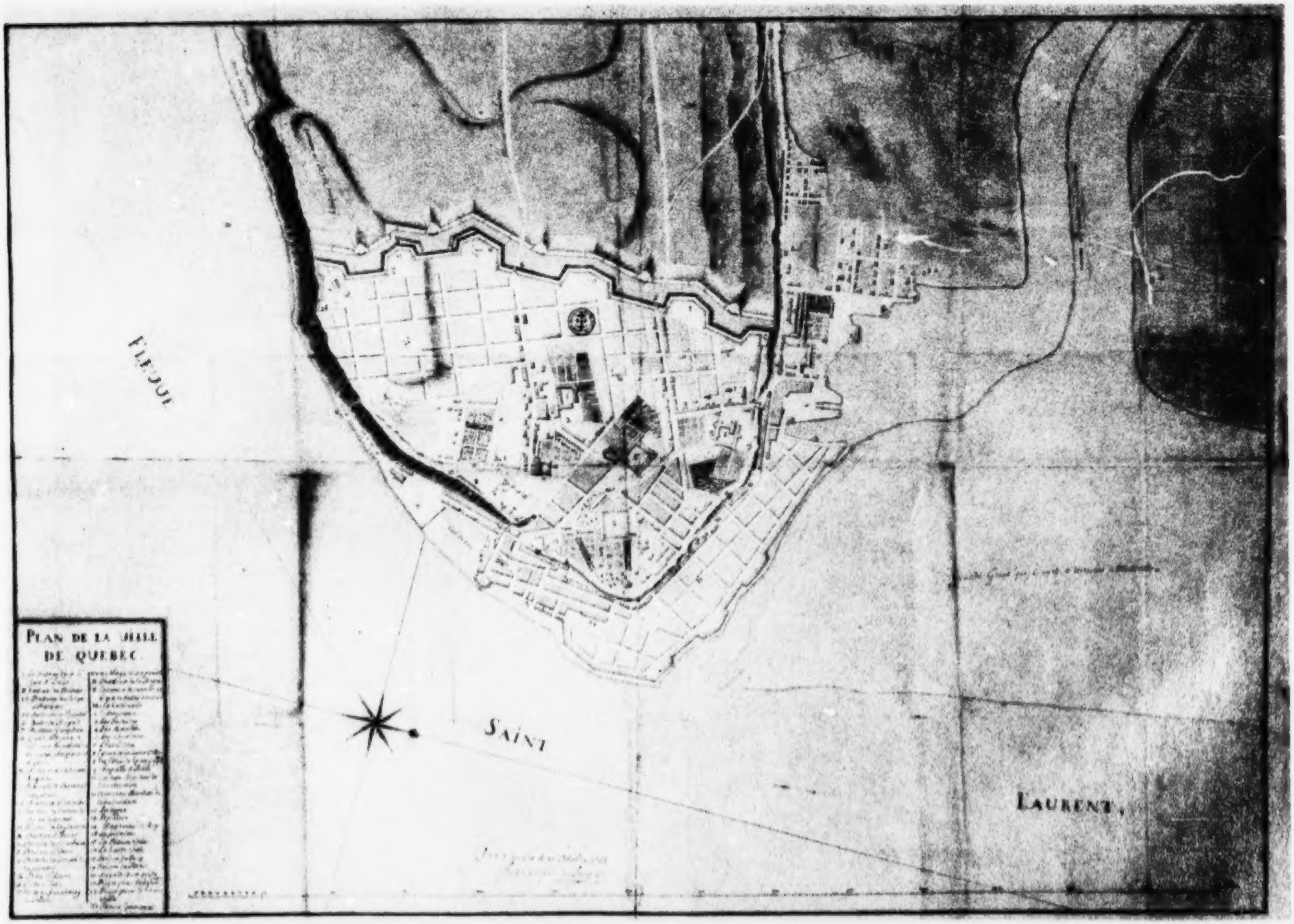
241 1758 siege. Detail from Figure 239. Breaches in the ramparts on King's-Dauphin front. (Bibliothèque Nationale, Paris.)


ARTIE
Lo
DE
VILLE
LOU
G
H
I
L
M
N
O
P
Q
R
S
T
V

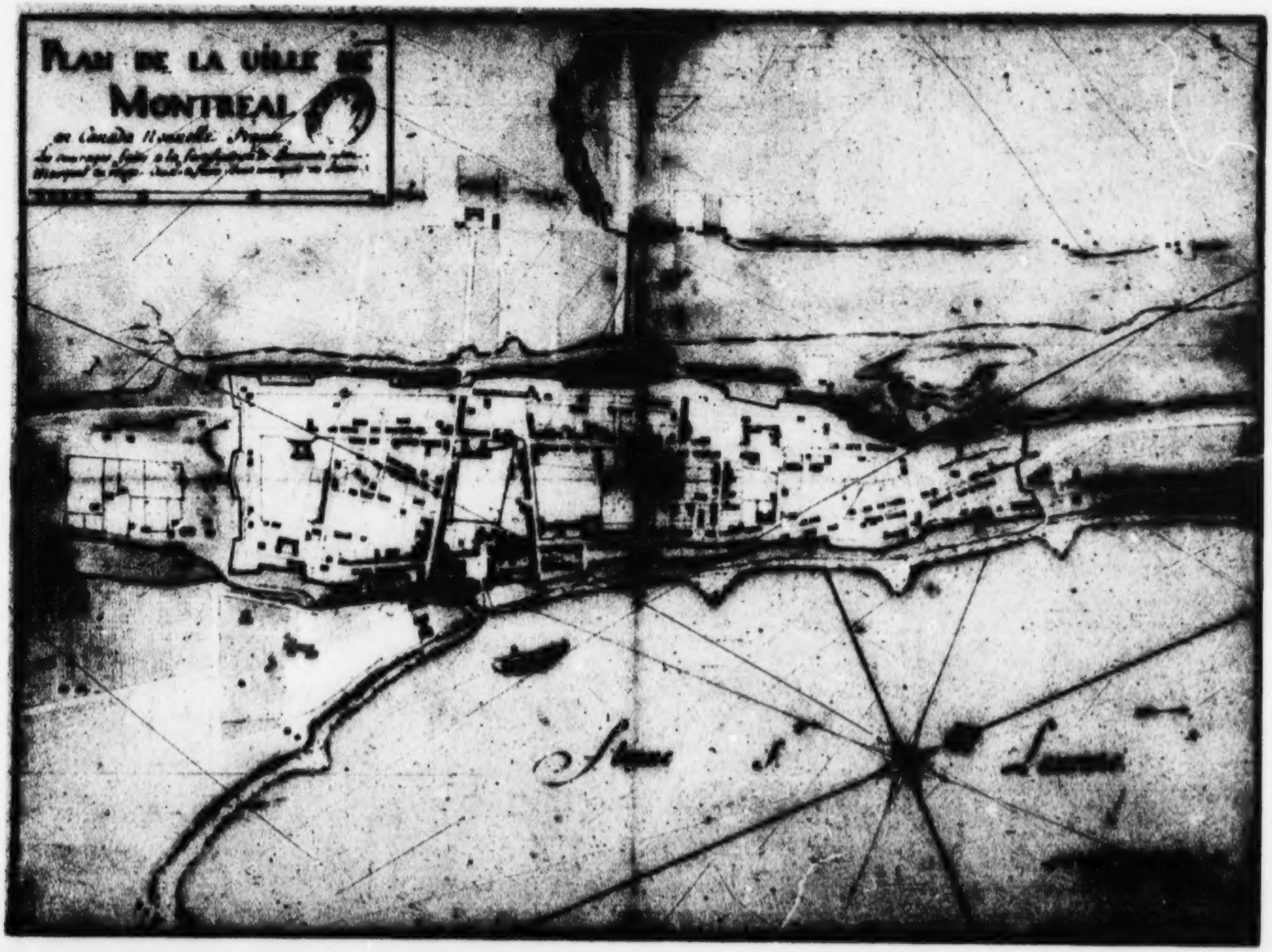
242 1758 siege. Detail of the hills used for British battery positions: V, hauteur de la justice; VI, lime-kiln hill; VII, Martissan Heights. (Bibliothèque de l'Arsenal, Paris.)


ANTIBES Ville et Port de Mer de Provence Sur la Mer Mediterranée Situé a 43 degrez 40. Minutes de Latitude 25. degrez 30. Minutes de Longitude.
la Ville
le Port
MER
MEDITERRANEE
Fort

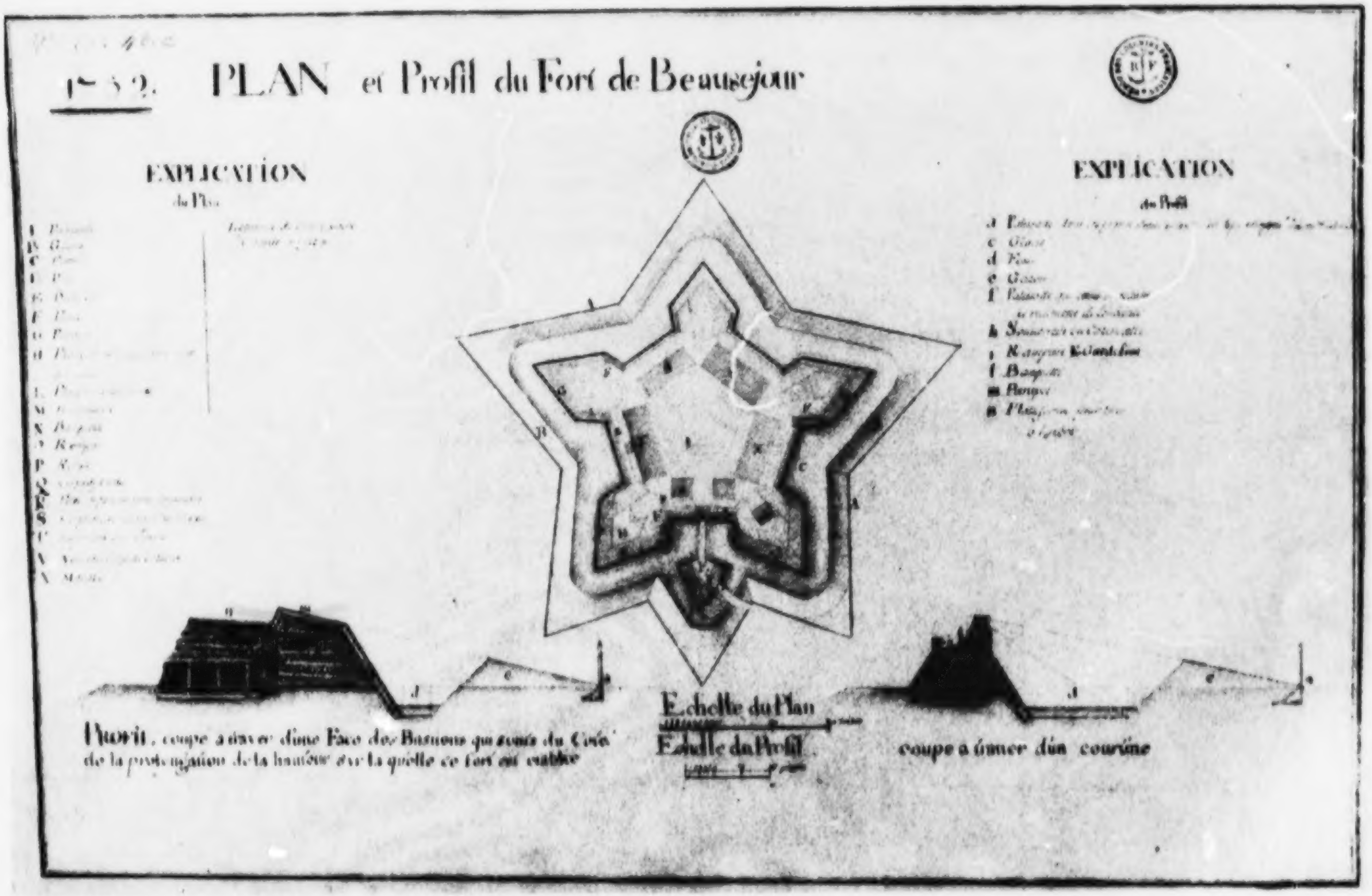
243 Antibes (Alpes-Maritimes). Small town of Greco-Roman origins on Mediterranean; 16th-century bastioned *enceinte*, modified and improved by Vauban. Coastline is defended by low parapet with frequent re-entrants for flanking fire; port is protected by a mole and, opposite the town on a hill, Le Fort Carré of 16th-century origin. (De Fer, *Force de l'Europe: Introduction à la fortification* [Paris, 1695], p. 42.)


PLAN DE LA VILLE DE QUEBEC
FLEUVE
SAINT
LAURENT.

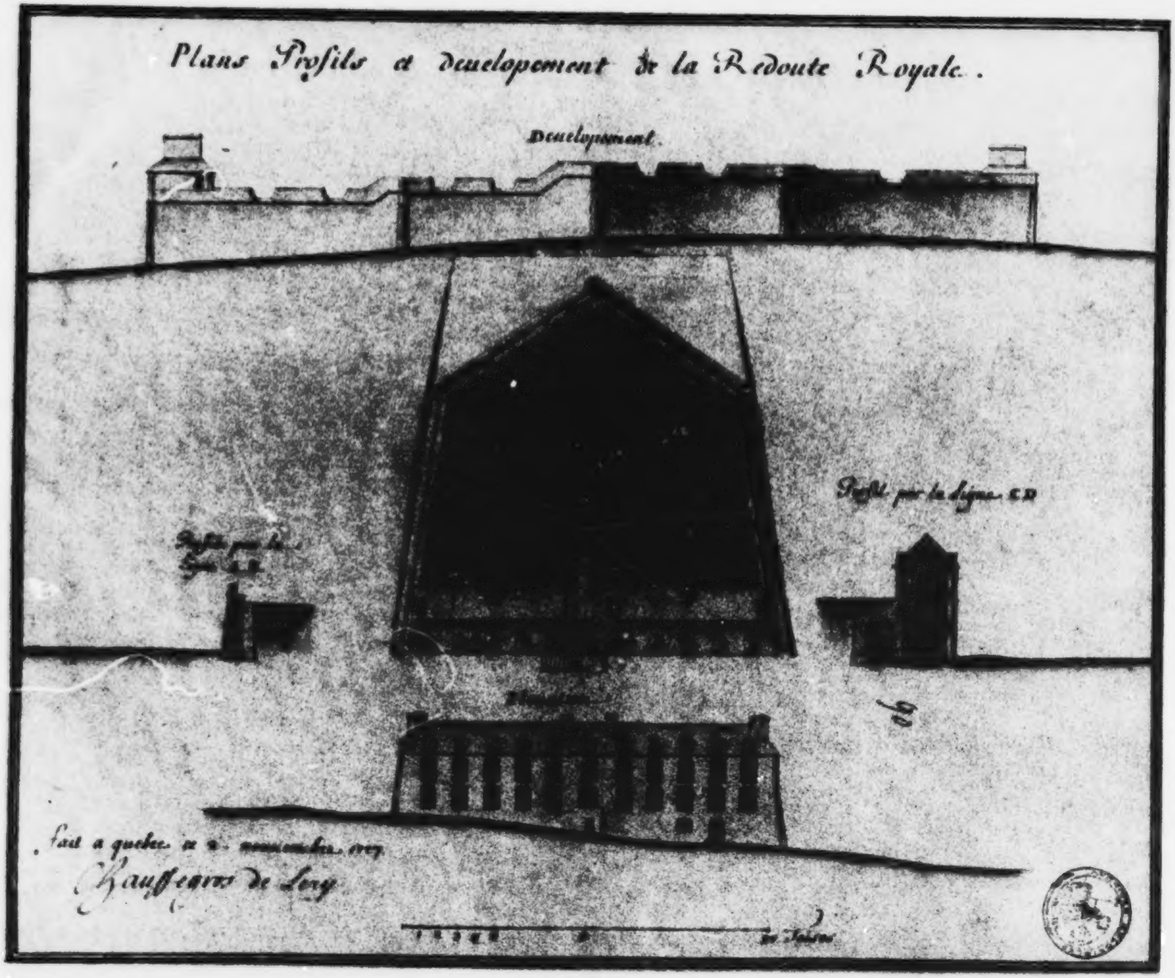
244 Quebec. Fortifications, Chaussegros de Léry, 1752. The main bastioned *enceinte* isolates the rocky promontory from westward approaches; rest of upper town is defended by low parapet with re-entrants. Lower town is provided with a bastioned *enceinte* along shoreline. (Public Archives Canada, C 21779.)


PLAN DE LA VILLE DE
MONTREAL
en Canada Nouvelle France
Fleuve St Laurent

245 Montreal. Chaussegros de Léry, 1727. Low, flanked defences surround the town at the water's edge; the ground rises continually to the west. (Archives Nationales, Paris.)

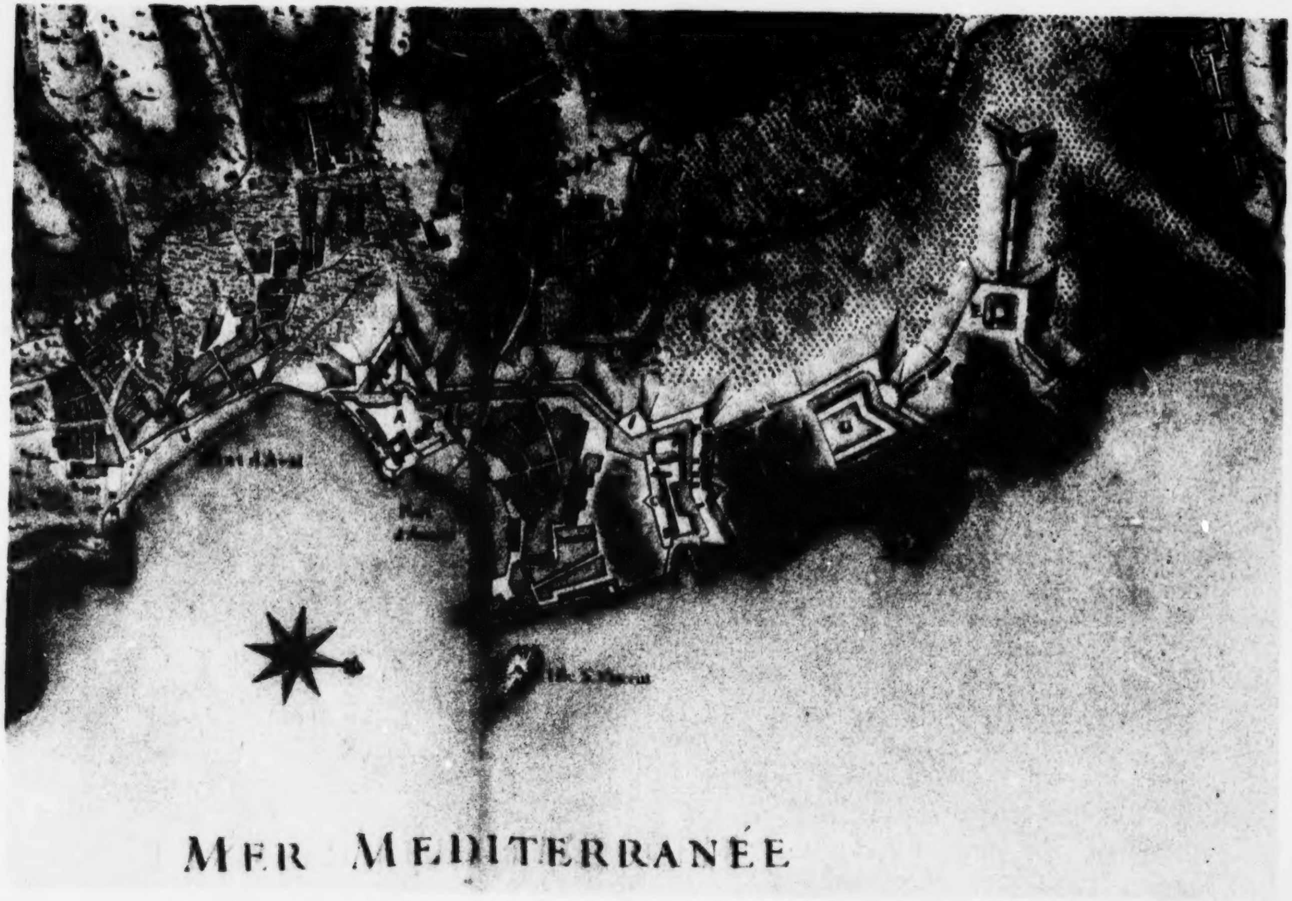

1752.
PLAN et Profil du Fort de Beausejour
EXPLICATION
du Plan
EXPLICATION
du Profil
Profil, coupe a travers d'une Face des Bastions qui sont du Coté de la prolongation de la hauteur sur la quelle ce fort est établi
Echelle du Plan
Echelle du Profil
coupe a travers d'un courtine

246 Fort Beauséjour. 1752. One of the more sophisticated frontier forts, based on a regular pentagon, using earth and timber construction. A casemate (H) is in one bastion, a powder magazine (R) in another. (Archives Nationales, Paris.)


Plans Profils et develop[p]ement de la Redoute Royale.
Developement.
Profil par la ligne CD
Profil par la ligne AB
Fait a quebec le 2 novembre 1717
Chaussegros de Lery
toises

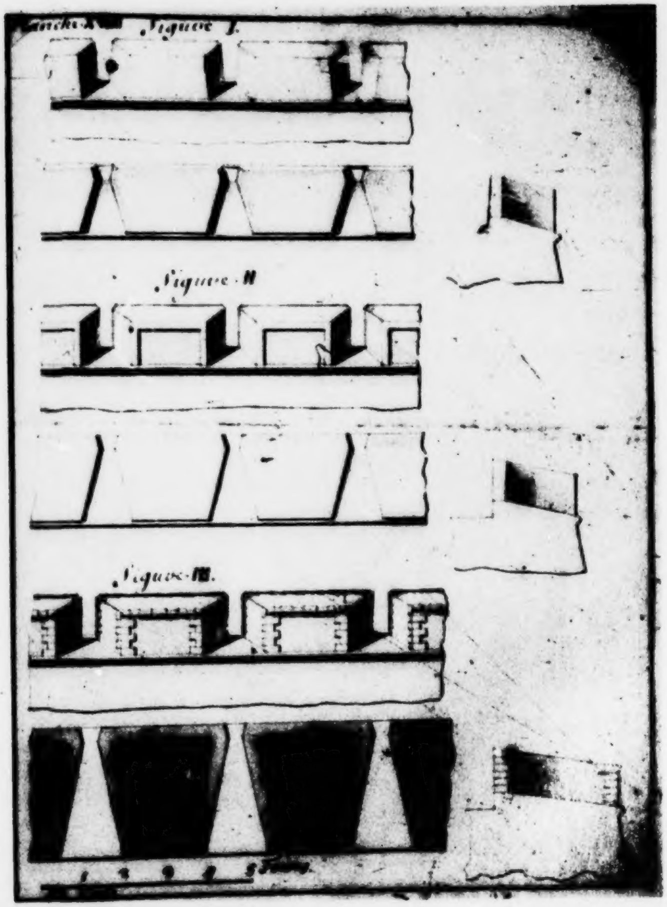
247 Quebec: Redoute bastionnée. One of the series of detached redoubts built to defend the western approaches to the town; later abandoned with construction of a regular bastioned *enceinte*. (Archives Nationales, Paris.)

248 Louisbourg. The fortifications and harbour entrance are in background of this aerial view. Broken ground and commanding heights leading almost to glacis are in foreground and middleground; lower slopes of Green Hill at extreme right. (Fortress of Louisbourg NHP.)

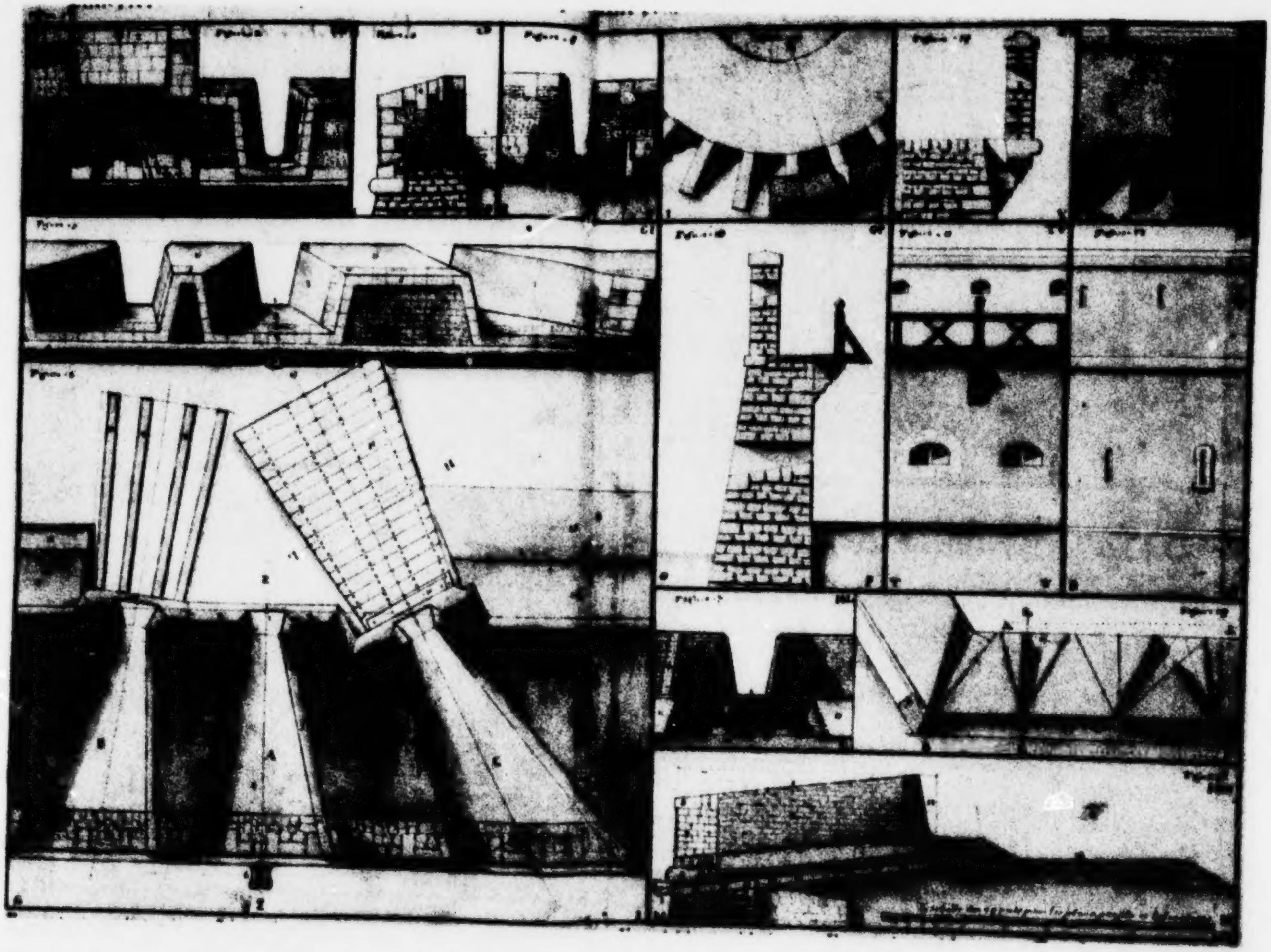


249 Collioure (Pyrénées-Orientales). Medieval chateau (A) guards old port and town; bastioned works were added in 16th century, improved by Vauban ca. 1670. He also added a large *demi-lune* on landward front of chateau and a series of detached works extending up hills to the north to cover commanding ground. Detached forts (C, G, E, F) were also located on heights south of the harbour. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)

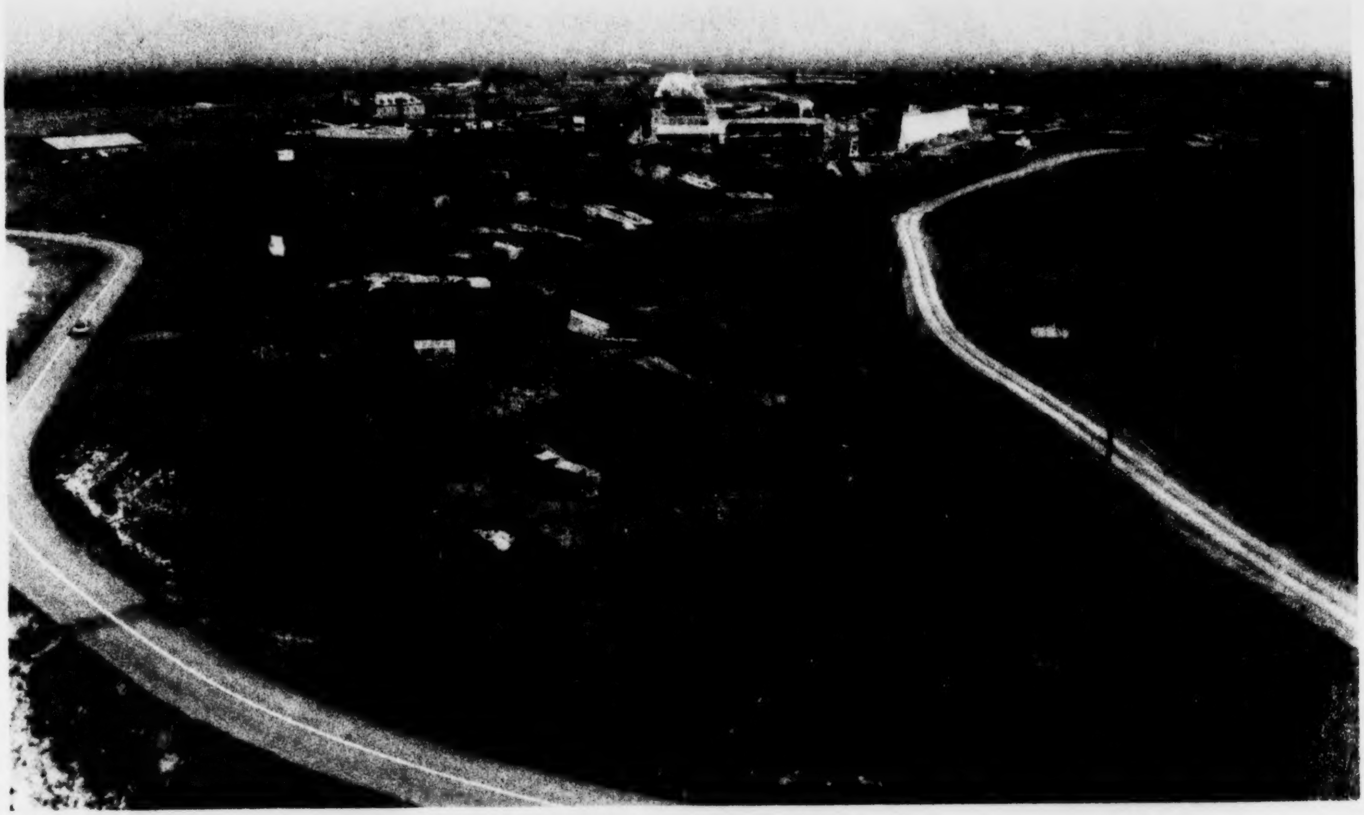
250 Collioure. Medieval chateau in lower left centre, 17th-century *demi-lune* at left. Fort and barracks (C on Fig. 249) dominates the town, centre right. Detached works (E and F, Fig. 249) may be seen on the ridge above the town. The small fort on the hill south of the harbour is in foreground. (Photo by author.)



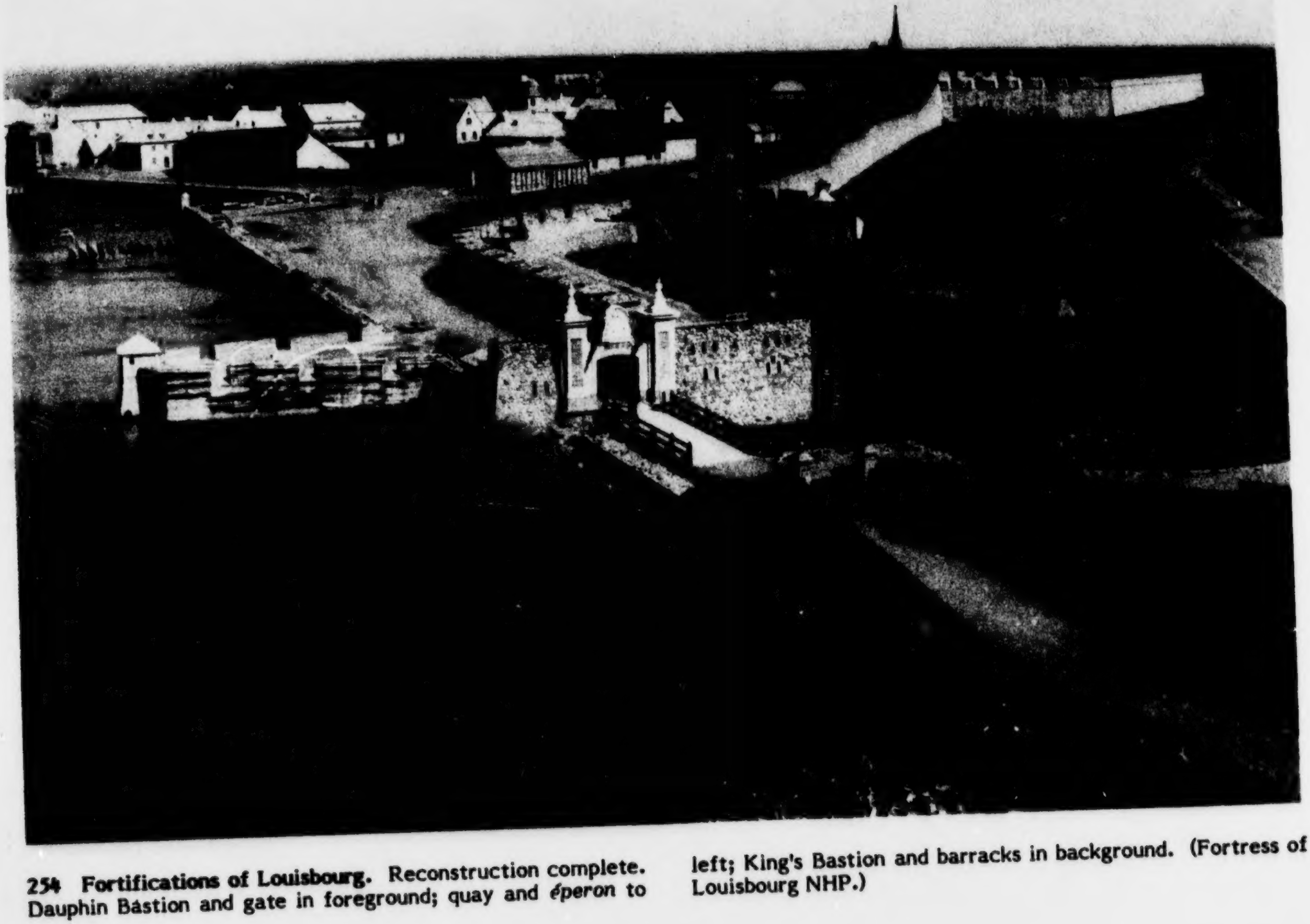
251 Embrasures. Variations recommended by Chaussegros de Léry. (Public Archives Canada.)



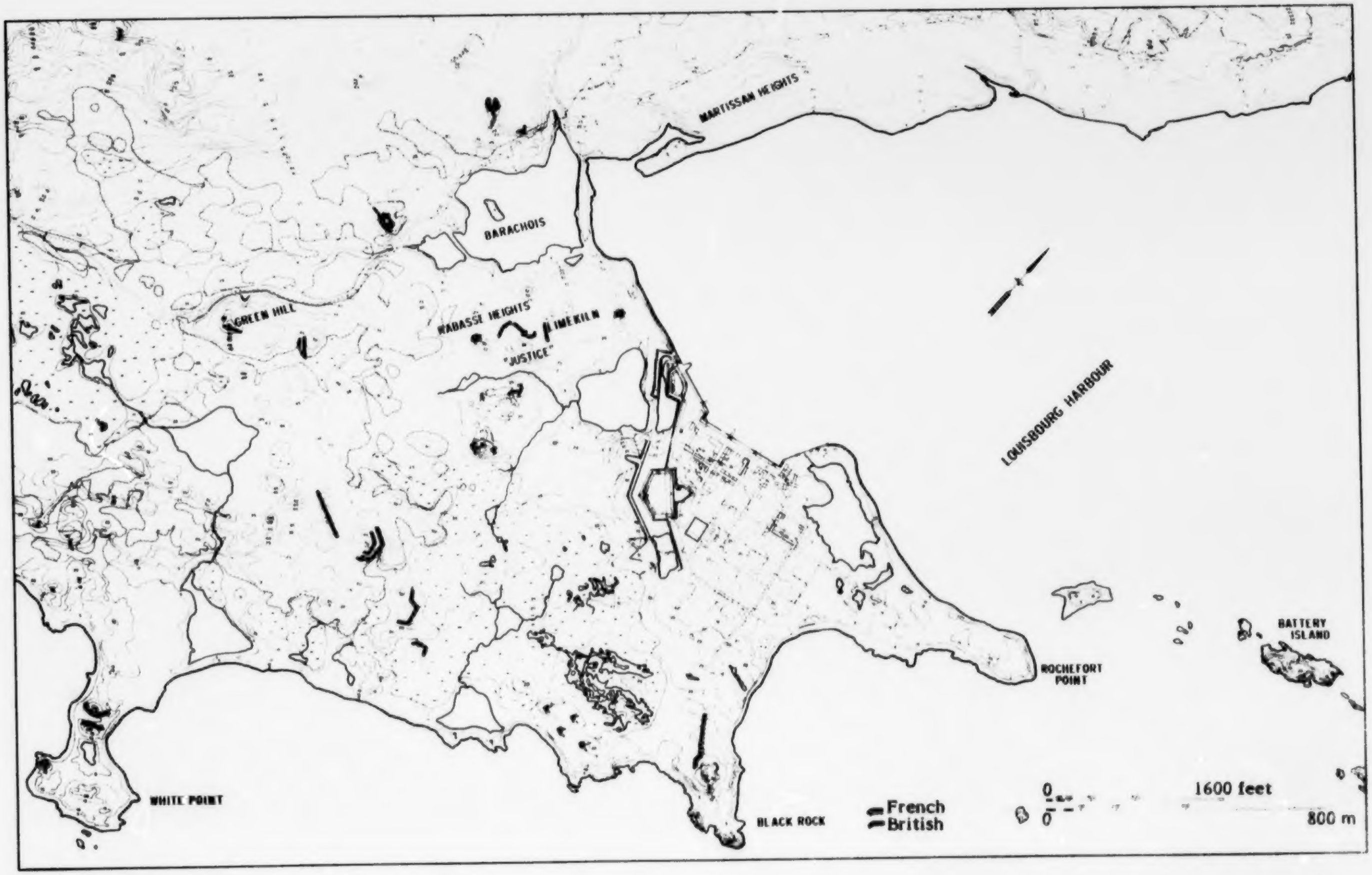
252 Embrasures and parapets. Variations recommended by Claude Masse. (Collections du Ministère de la Défense, Bibliothèque du Génie, Paris.)



253 Fortifications of Louisbourg. Excavation and reconstruction. The Dauphin Bastion is at an early stage of excavation (foreground); construction is in progress on the King's Bastion and barracks (background). (Fortress of Louisbourg NHP.)



254 Fortifications of Louisbourg. Reconstruction complete. Dauphin Bastion and gate in foreground; quay and *éperon* to left; King's Bastion and barracks in background. (Fortress of Louisbourg NHP.)

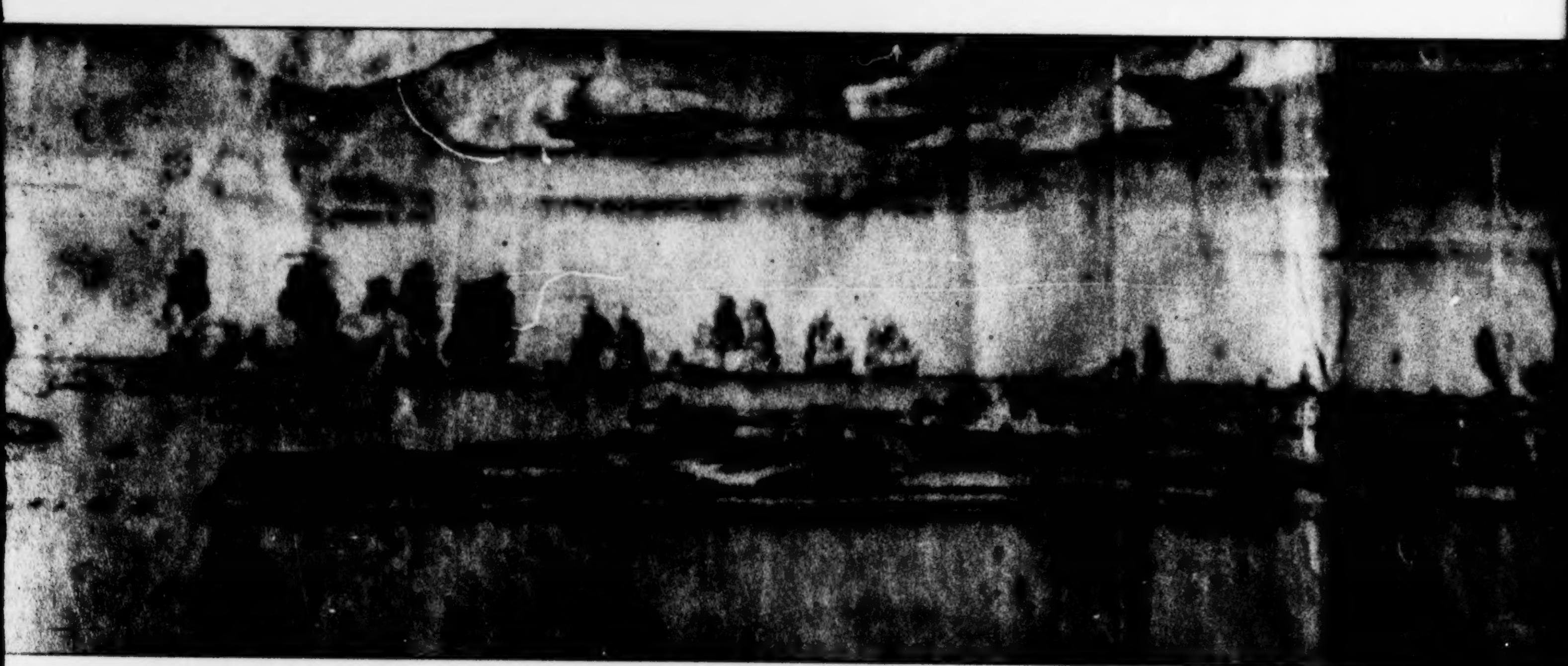

MARTISSAN HEIGHTS
BARACHOIS
GREEN HILL
RABASSE HEIGHTS
LIMEKILN
"JUSTICE"
LOUISBOURG HARBOUR
BATTERY ISLAND
ROCHEFORT POINT
WHITE POINT
BLACK ROCK
French
British
0
1600 feet
0
800 m

255 Fortress area: French and British field fortifications. Five-foot contour intervals based on 1962 survey. (Drawing by T.M. Smith.)

256 **The town and walls of Louisbourg** as seen from Martissan Heights (the location of Titcomb's Battery, 1745). (Fortress of Louisbourg NHP.)

The French defended their North American territories with isolated forts at strategic sites in the wilderness and with bastioned masonry walls around the three towns important enough to warrant such fortifications: Montreal, Quebec and Louisbourg. Documentary, architectural and archaeological evidence reveals to what extent the French, then predominant in military engineering, applied long-established Old World methods at Louisbourg and to what extent they adapted to the different physical and military environment of the New World. Twice besieged, Louisbourg was twice taken. Yet in both sieges it held out, unaided, for more than six weeks after the enemy had landed. More could not have been asked.

Volume One: text; Volume Two: illustrations.



Canada